Micrion 8000 Series
Focused Ion Beam System
Service Procedures Manual

Including Procedures for the Micrion 9800 FlipChip and the MicroMill HT Systems.

Part No. 800-000049
Revision B, 3/97

Micrion

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Monthly
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Section 1: Power Up/Down

- 01-01 Power Up
- 01-02 Power Down, Vent, and Reset

Micron

Service Procedure No.: **01-01**
Service Procedure Title: **Power Up**
Applicable Systems: **All**
Frequency of Service: **As needed**

Introduction

This procedure begins with the power connections for the system and its subsystems at installation; most field maintenance work begins with Part 2 or Part 3.

Tools and Materials Required

Circuit tester

Part 1. Power Cords

1-1. This procedure begins with the system AC power disconnected and all circuit breakers in the Power Distribution Unit (PDU) switched off. See Figure 1.

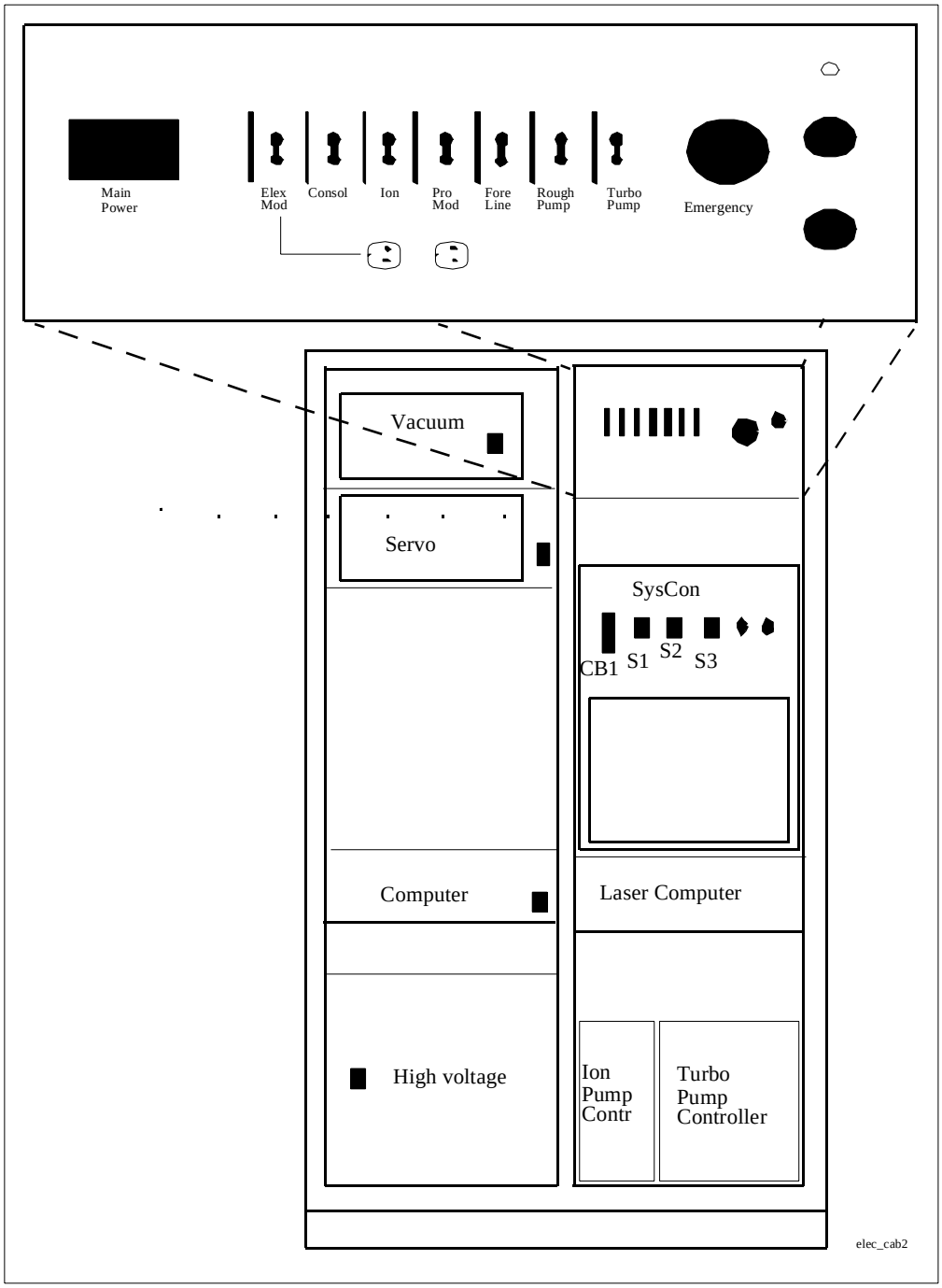


Figure 1 Circuit Breakers and Power Switches, Front of Electronics Module

1-2. Plug in the main power line as shown in Figure 2.

1-3. Switch on all circuit breakers in the PDU.

1-4. Use a circuit tester to test the power strips that are shown in Figure 2.

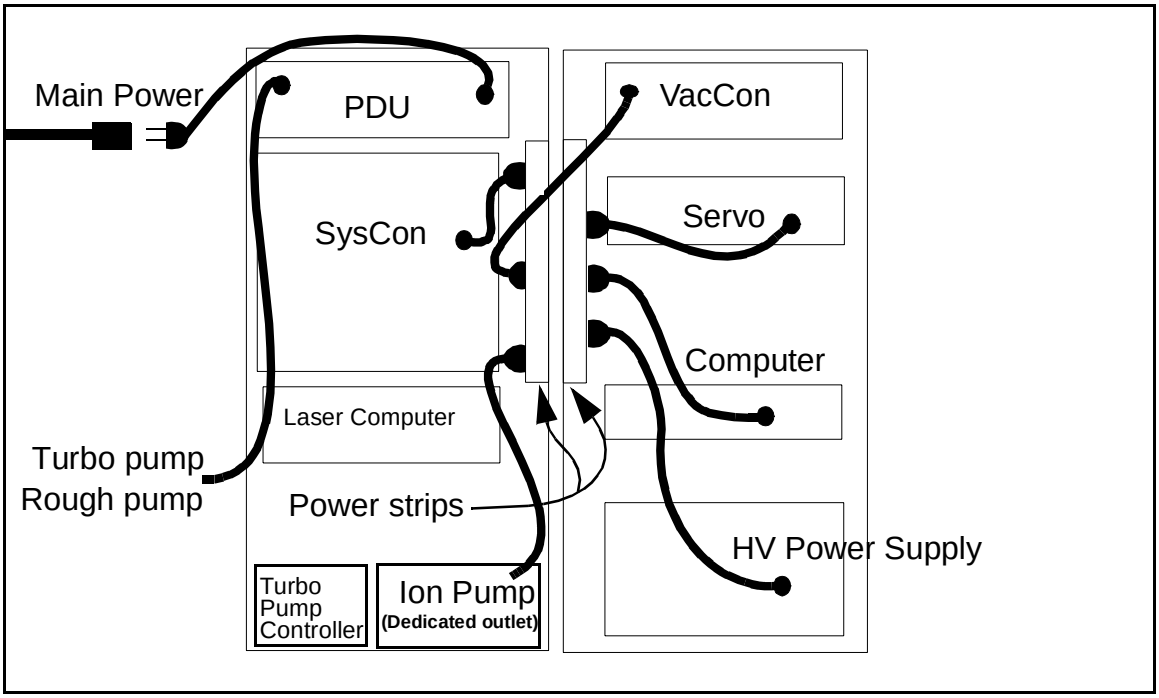


Figure 2. Power Cords and Power Strips, Rear of Electronics Module

1-5. Switch off all circuit breakers in the PDU.

1-6. Plug the VacCon, Servo, and SysCon module power cords and the Ion Pump power cord into the power strips.

NOTE: The ion pump has its own dedicated outlet on the left power strip, as shown in Figure 2.

Part 2. If the Emergency Stop Switch is Pushed In:

If the emergency stop switch is pushed in, proceed as follows:

2-1. Release the emergency switch from its detented position.

2-2. Push the green ON button next to the EMO.

Part 3. Creating a Vacuum and a Beam

Once the system is connected to a power source, use the following steps to create a beam.

3-1. Turn on water, air, and nitrogen.

3-2. Switch on all circuit breakers in the PDU.

3-3. Switch on the computer.

3-4. Wait for the bootstrap.

3-5. Log in as *micrion.*

3-6. To create a vacuum, in a *vacchat* window type the automatic pump-down command:

`ap` (see Service Procedure 04-03)

3-7. To cure the column, follow Service Procedure 05-12. The length of the cure depends upon the length of time the chamber was vented.

3-8. To heat the source, follow Service Procedure 05-11.

3-9. From the application program screen, select *Powerup. Powerup* performs an orderly restart of the ion beam, including stage movement to the ion faraday and electron faraday cups.

Micrion

Service Procedure No.: **01-02**
Service Procedure Title: **Power Down, Vent, and Reset**
Applicable Systems: **All**
Frequency of Service: **As Needed**

Introduction

You should power down when you want to get into some part of the hardware system, such as the SysCon module or the chamber, or when you want to disconnect cables from the column, etc. There are automatic as well as manual procedures for powering down, resetting, and venting.

Vent

Using the autovent command or a series of manual vent commands, you can disable the vacuum pumps and bring the pressure in the chamber to atmosphere. Some systems are equipped with a single fore/rough pump, and other systems have dual (fore and rough) pumps. The autovent command will automatically vent either type of system. Manual venting procedures are different for single versus dual pump systems, and are described in Part 3.

Reset

Reset refers to the reset of the computer and the SysCon module. Reset after emergency shutdown is also included in this procedure.

Requirements

- *vacchat* window open (see Service Procedure 09-03)
- FIB application running
- Access to the switches shown in Figure 1

NOTICE

Per paragraph 11.1 of *Safety Guidelines for Semiconductor Manufacturing Equipment* (S2-93), this procedure is a Type 3 task. Specifically: "Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are less than 30 volts RMS, 42.2 volts peak, 240 volt-amps, and 20 Joules."

Part 1. System Preparation

Configure the Chemical Sources in "Safe" Mode

Before performing the tasks described in this procedure, you must put the chemical sources in a "safe" mode; see Service Procedure 02-01.

WARNING

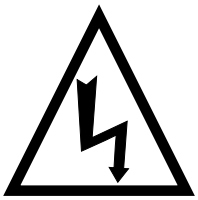
Do not proceed until the chemical sources are secure. The chemical reservoirs in FIB systems contain hazardous materials. Labels affixed to the exterior of a chemical cabinet identify the chemical(s) contained inside. If a chemical source is not in its "safest" state, as described in **Service Procedure 02-01**, it is possible for a combination of component failures to release the chemical(s) through a cabinet's delivery line, a roughing line, a purging line, or from a chemical reservoir into the workchamber. Do not open the workchamber, or disassemble any part of the vacuum pumping system, or detach any gas line from any chemical cabinet until you are sure that every chemical source attached to the FIB system is in its "safest" state.

Part 2. Power Down

This procedure begins with the FIB application program running. The first task is to bring down the high voltage.

2-1. Power down the column through the application program.

WARNING



Dangerously high voltages are present in the process module while the FIB system is powered up. Do *not* rely only on the software Power Down function. Disable the voltages using both manual and automatic procedures.

2-2. On the SysCon module, switch OFF the Deflection, MCP, and Flood Gun power swtiches (S1, S2, and S3).

2-3. Select the task you are going to perform, and switch off the specified switches that are listed in Table 1 and shown in Figure 1**.**

Table 1: Subsystems and Which Circuits to Switch Off

To work on:	Switch OFF:
Ion Beam Column/ High Voltage Power	HV Power Supply(s)/Focus Power Supply
SysCon Boards	S1, S2, S3, CB1
VacCon Boards	Vacuum Control
Servo Boards, Motors	Servo Control
Workchamber	HV Power Supply(s)/Focus P/S, CB1, S1, S2, S3
Turbo Pump	HV Power Supply(s)/Focus P/S, CB1, S1, S2, S3, Fore, Rough, and Turbo CBs
MCP module	S2

2-4. To vent the system, go to Part 3.

When all necessary manual switches have been switched off, you can safely perform your task.

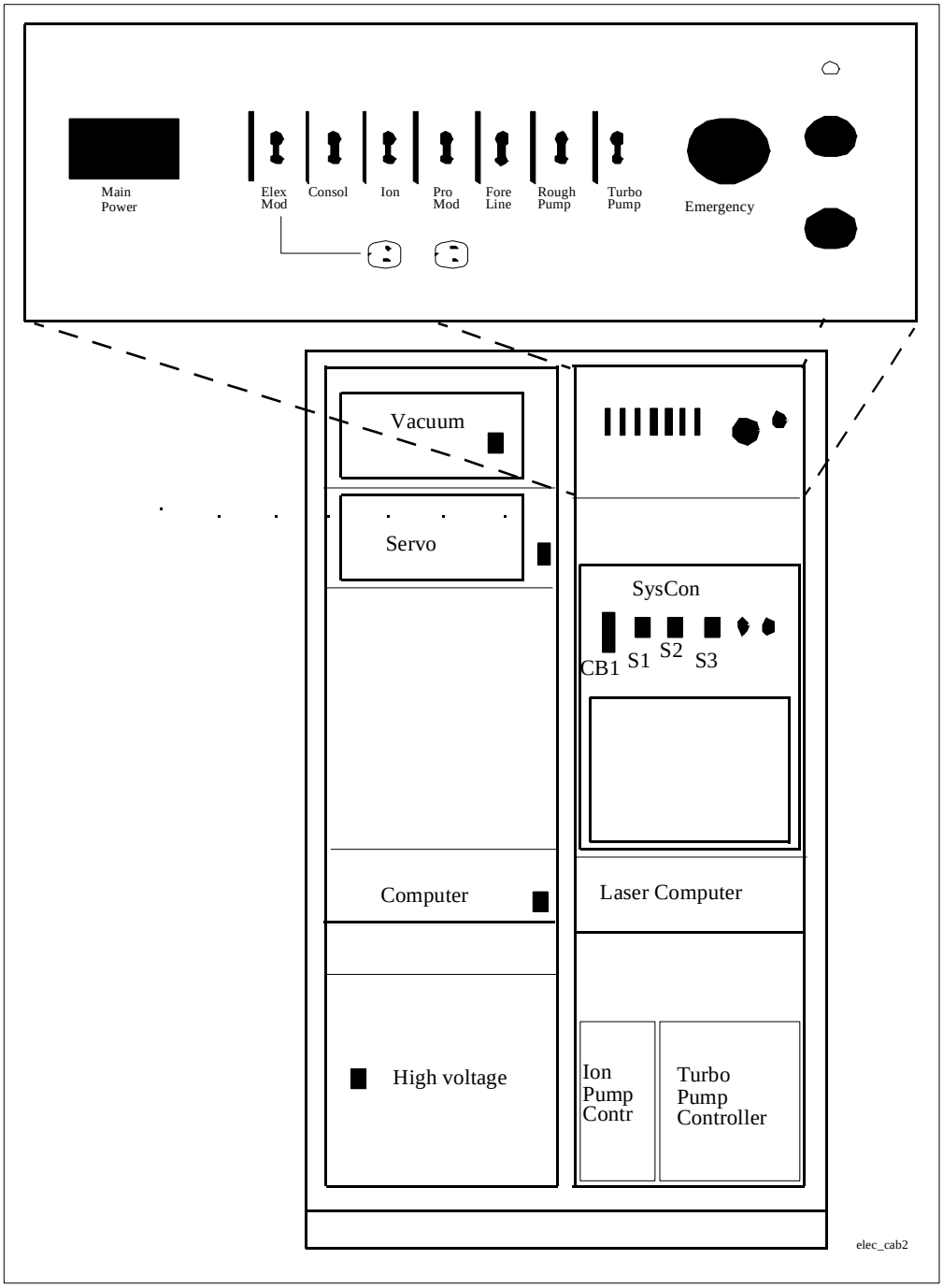


Figure 1. Circuit Breakers and Power Switches, Front of Electronics Module

Table 2 shows the order in which the system may be powered down all the way. You do not have to power down all the way for most of your repair and maintenance procedures.

Table 2: System Shutdown

system state	ion column status	Application program	vacuum status	X Windows & Process Watcher program	AIX	computer status	electrical power status	fluids status	to go to next lower state:
8	powered up	running	at vacuum	running	running	on	on	enabled	select *Powerdown* function
7	powered down	running	at vacuum	running	running	on	on	enabled	select *Quit* function
6	powered down	not running	at vacuum	running	running	on	on	enabled	enter *av* command (*vacchat*)[a]
5	powered down	not running	at atmosphere	running	running	on	on	enabled	click on *Quit & Exit* (Watcher)
4	powered down	not running	at atmosphere	not running	running	on	on	enabled	enter *shutdown* command (AIX)[b]
3	powered down	not running	at atmosphere	not running	not running	on	on	enabled	switch com-puter off
2	powered down	not running	at atmosphere	not running	not running	off	on	enabled	switch main breaker off
1	powered down	not running	at atmosphere	not running	not running	off	off	enabled	shut off water, air, & nitrogen
0	powered down	not running	at atmosphere	not running	not running	off	off	disabled	

a. Start the vacchat program through the Process Watcher program's window. Wait for venting to complete before proceeding.
b. You must log out and log in again as *root* (password required) to execute the shutdown command.

Part 3. Automatic and Manual Venting

To extend the life of the floodgun, allow 15 to 30 minutes for the flood gun to cool down before venting the system. There are two ways to vent a system: automatically and manually. Each of these procedures assumes that the workchamber has been pumped down and that the fore (fore and rough pumps for systems with dual "wet" pumps) and turbo pumps are running.

3-1. To automatically vent the system, proceed as follows:

a. Make sure that the loadlock door is shut.

b. Open a *vacchat* window (see Service Procedure 09-03).

c. At the *vacchat* prompt, type the *autovent* command to vent the system:

```
av
```

3-2. **To manually vent a single (fore/rough) pump system**, proceed as follows (see Figure 2 for valve locations):

a. Make sure that the loadlock door is shut.

b. Open a *vacchat* window (see Service Procedure 09-03).

c. At the *vacchat* prompt, check the status of the valves by typing:

```
sv
```

The system will display the status of the valves:

```
V1C V2C V3C V4C V5C V6C VIO VTIO VTPO
```

The valves should be in the states shown above; V1 through V6 should be closed, and VTP and VTI should be open.

If any of the valves V1 through V6 is open, close each valve by typing the *vacchat* close command. For example, V1 is closed with the following command:

```
clv1
```

d. To begin manual pump down of the loadlock, close VTP and VTI with the following *vacchat* commands:

```
clvtp
```

```
clvti
```

Be sure that VTI is closed before proceeding with the loadlock pumpdown. If VTI is not closed before loadlock pumpdown begins, the vacuum in the turbo pump line will suck contaminants from the roughing (and possibly the exhaust) line into the turbo pump and the workchamber.

e. Open V1 and V3 with the following *vacchat* commands:

```
opv1
```

```
opv3
```

Wait approximately 5 seconds, then open V4 by typing:

```
opv4
```

Opening V3 begins the evacuation of the loadlock through a small diameter vacuum line, and at a relatively low flow rate; this reduces the amount of particulate contamination generated by the evacuation of the loadlock. Opening V4 continues the evacuation of the loadlock through a large diameter vacuum line.

f. Close V3 with the following *vacchat* command:

```
clv3
```

g. Check the status of TC2 by typing:

```
stt2
```

h. When TC2 < 0.065 torr, close V1 by typing:

```
clv1
```

i. At the *vacchat* prompt, type the following command:

```
opv2
```

j. Shut off the ion pump, the HCIG, the turbo pump, and the fore pump with the following commands:

```
ipn
```

```
hcpd
```

```
hpn
```

```
fpn
```

k. Wait a minimum of two minutes for the turbo pump to stop spinning.

l. Open the vent valve with the following command:

```
opv5
```

m. It will take up to 20 minutes for the workchamber and loadlock to reach atmospheric pressure. Check pressure in the loadlock and workchamber by typing the following *vacchat* command:

```
stlp
```

The system will respond with either:

```
The loadlock is under vacuum
```

or

```
The loadlock is at atmosphere
```

Because V2 and V4 are open, the workchamber and the loadlock are at the same pressure.

n. When the system reports that the loadlock (and workchamber) is at atmosphere, type the following commands:

```
clv2
```

```
clv4
```

```
clv5
```

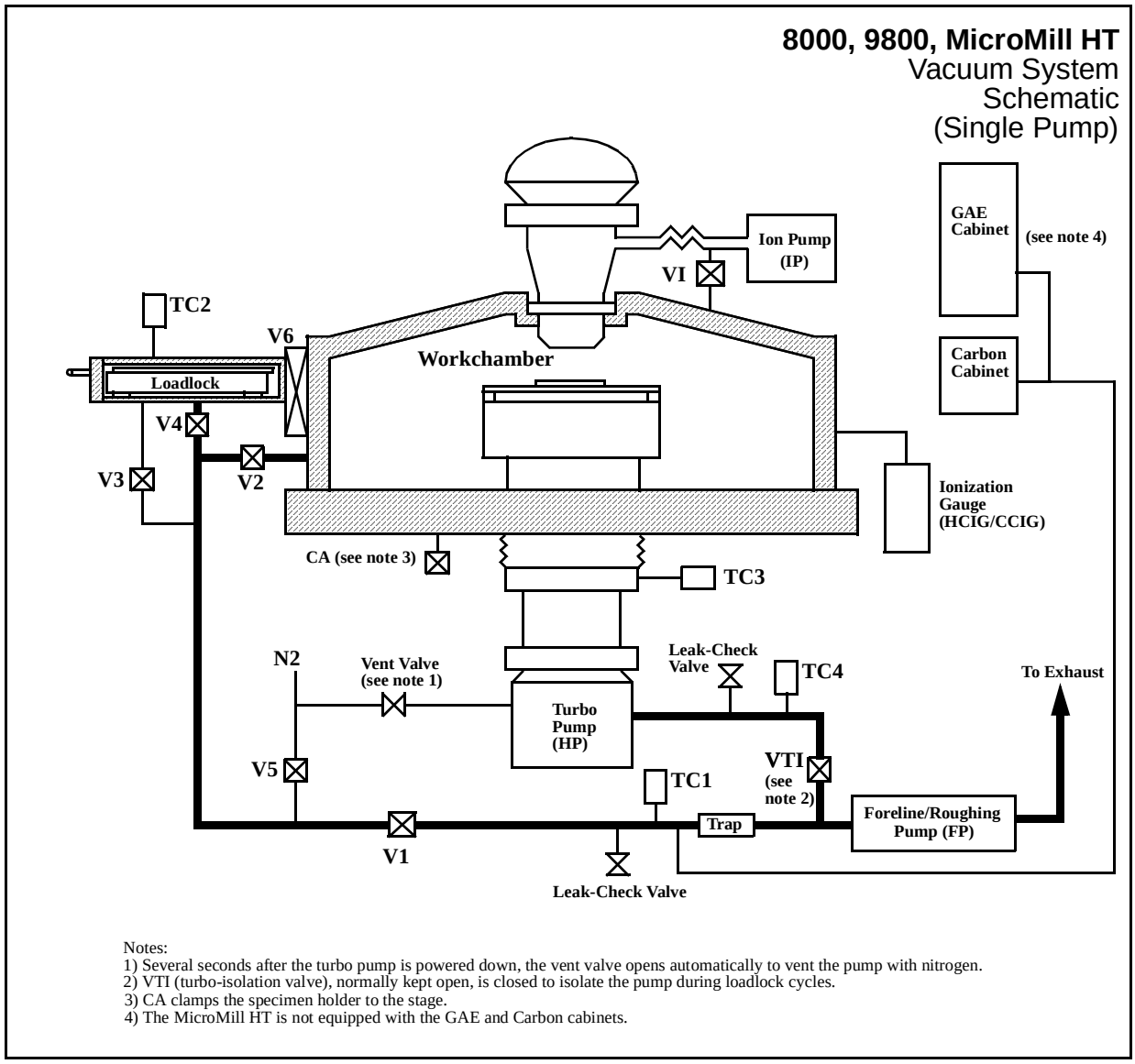


Figure 2. Single Pump Vacuum System

3-3. **To manually vent a dual (fore and rough) pump system**, proceed as follows (see Figure 3 for valve locations):

a. Make sure that the loadlock door is shut.

b. Open a *vacchat* window (see Service Procedure 09-03).

c. At the *vacchat* prompt, check the status of the valves by typing:

```
sv
```

The system will display the status of the valves:

```
V1C V2C V3C V4C V5C V6C VIO
```

The valves should be in the states shown above; V1 through V6 should be closed, and VI should be open.

If any of the valves V1 through V6 is open, close each valve by typing the *vacchat* close command. For example, V1 is closed with the following command:

```
clv1
```

d. Turn on the rough pump by typing:

```
rpy
```

e. Open V1 and V3 with the following *vacchat* commands:

```
opv1
```

```
opv3
```

Wait approximately 5 seconds, then open V4 by typing:

```
opv4
```

Opening V3 begins the evacuation of the loadlock through a small diameter vacuum line, and at a relatively low flow rate; this reduces the amount of particulate contamination generated by the evacuation of the loadlock. Opening V4 continues the evacuation of the loadlock through a large diameter vacuum line.

f. Close V3 with the following *vacchat* command:

```
clv3
```

g. Check the status of TC2 by typing:

```
stt2
```

h. When TC2 < 0.065 torr, close V1 by typing:

```
clv1
```

i. Turn off the rough pump with the following *vacchat* command:

```
rpn
```

j. At the *vacchat* prompt, type the following command:

```
opv2
```

k. Shut off the ion pump, the HCIG, the turbo pump, and the fore pump with the following commands:

```
ipn
```

```
hcpd
```

```
hpn
```

```
fpn
```

l. Wait a minimum of two minutes for the turbo pump to stop spinning.

m. Open the vent valve with the following command:

```
opv5
```

n. It will take up to 20 minutes for the workchamber and loadlock to reach atmospheric pressure. Check pressure in the loadlock and workchamber by typing the following *vacchat* command:

```
stlp
```

The system will respond with either:

```
The loadlock is under vacuum
```

or

```
The loadlock is at atmosphere
```

Because V2 and V4 are open, the workchamber and the loadlock are at the same pressure.

o. When the system reports that the loadlock (and workchamber) is at atmosphere, type the following commands:

```
clv2
clv4
clv5
```

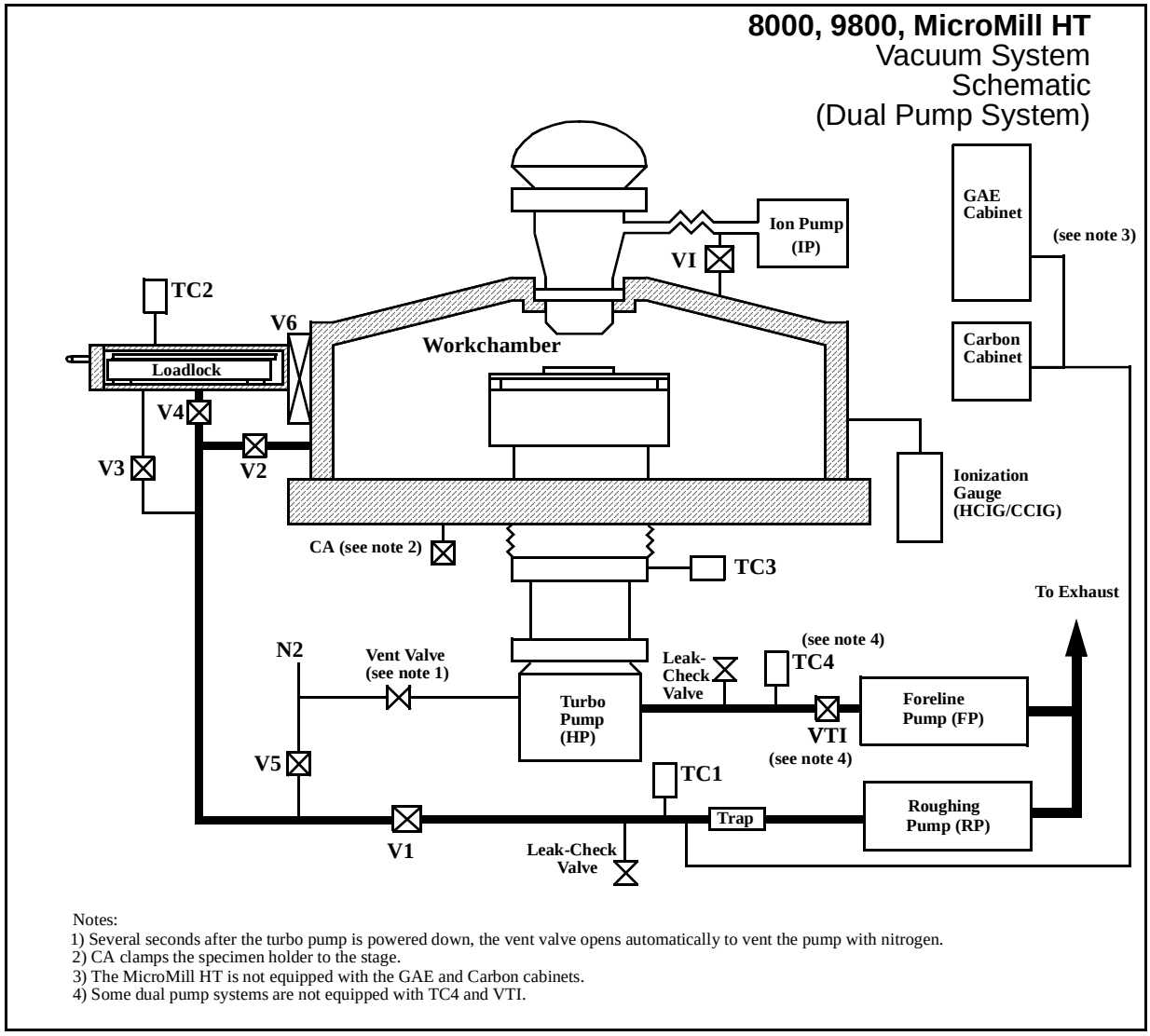


Figure 3. Dual Pump Vacuum System

Part 4. Shutdown

4-1. Quit the FIB application and click the *Quit & Exit* button on the Process Watcher.

4-1. At the shell prompt (not in an xterm window), log out of the system.

4-2. Log in as root and enter the password.

4-3. As the root user, enter the command:

```
shutdown now
```

This command shuts down the operating system in an orderly and safe manner.

NOTICE: DO NOT PRESS THE RESET BUTTON

If an application hangs (no mouse response), DO NOT use the computer Reset button to reboot. Use of the Reset button crashes the operating system. To clear the hang, press the three keys: CTRL-ALT-BACKSPACE; this will terminate X Windows without crashing the operating system. Then type `xinit` at the shell prompt to start the user interface (X Windows).

Part 5. Resetting After an Emergency Shutdown

An emergency shutdown is one in which someone pressed the red EMO button. To recover, proceed as follows:

5-1. Switch the computer off.

5-1. Release the Emergency button (above the SysCon section) from its detented position.

5-2. Press the green ON button next to the Emergency button.

5-3. Switch the computer on.

5-4. Log back in to the computer (the application restarts automatically; see Service Procedure 01-01).

Section 2: Chemical Safety

- 02-01 Securing Chemical Sources in Safe Mode
- MSDS Apiezon A Oil
- MSDS Perfluorinated pPolyethers (Fomblin)
- MSDS Gallium Ingot
- MSDS Oxygen
- MSDS Platinum (II) hexafluoroacetylacetonate
- MSDS Styrene
- MSDS TEOS (Tetraethoxysiloxane)
- MSDS TMCTS (Tetramethylcyclotetrasiloxane)
- MSDS Tungsten carbonyl
- MSDS Xenon difluoride

Micrion

Service Procedure No.: **02-01**
Service Procedure Title: **Securing Chemical Sources in the Safe Mode**
Applicable Systems: **All**
Frequency of Service: **As needed**

Introduction

This procedure describes the process of securing the chemicals in the system so that maintenance and repair procedures can be carried out safely.

To reduce the risk of accidental exposure to toxic chemicals while working on the FIB system, place the chemical subsystems in the "safe" mode as specified in this section.

Before venting and opening the FIB process module, let the system run under high vacuum for 12-24 hours after using any chemical.

Materials Required

This procedure requires the use of the following materials:

- Standard field service tools
- Nitrile rubber gloves
- Cylinder shutoff tool

WARNING

The chemical cabinets attached to FIB systems normally contain hazardous materials. Labels affixed to the exterior of a chemical cabinet identify the chemical(s) contained inside. If a chemical cabinet is not in its "safest" state, as defined below, it is possible for a combination of component failures to release the chemical(s) through the cabinet's delivery line, its roughing line, or its purging line. Do not open the workchamber, disassemble any part of the vacuum pumping system, or detach any gas line from any chemical cabinet until you are sure that every chemical cabinet attached to the FIB system is in its "safest" state.

Part 1. Secure the GAE Cabinet

Configure the GAE cabinet in the "safe" mode as follows.

1-1. Make sure that the GAE cabinet exhaust system is operating correctly. Note the position of the exhaust gate valve (so that you can restore it later). Open the exhaust gate valve fully before opening the GAE cabinet door.[1]

1-2. Open the GAE cabinet door and by-pass the safety interlock shut-off switch as follows:

By-pass the switch with the cabinet door open by pulling the switch actuator toward you until it clicks into the extended by-pass position.

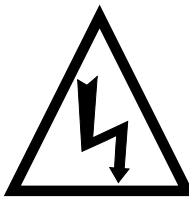
(Opening the cabinet door has the same effect as shutting off the Pneu Valve Shutdown switch. It shuts off the dc power controlling the pneumatic valves. By-passing the switch restores dc power to the pneumatic valves.)

1-3. With dc power for controlling the pneumatic valves enabled, make sure that the push-button switch labeled *Pneu Valve Shutdown* on the GAE cabinet is illuminated (green).

1-4. Close the manual valve on the Xenon Difluouride (XeF_2) cylinder assembly by turning it 1/4 turn clockwise.

1-5. Use the Gas Control popup (in the Misc menu), to make sure that valves V12 through V17, and V20 are closed. To close valve V17, click on the valve icon to obtain the setpoint dialog box, then click on the *LeakValve* toggle button so that it reads *OFF*.

WARNING



Do not touch the connectors exposed on the bank of solenoid-operated valves in the upper left-hand corner of the GAE cabinet. When the Pneu Valve Shutdown switch is on, there is a 24 volt, 5 ampere, dc potential present on the connectors. A short-circuit caused by introducing a conductive metal object such as a tool or a finger ring could generate enough heat energy to cause burns before the power supply automatically switches off.

1-6. Pump out the chemical delivery lines in the GAE cabinet up to V12:

a. Start the roughing pump by clicking on the RP (FP for single pump systems) icon in the Gas Control Popup.

b. When TC1 reads ≤0.01 torr, open V13, V15, and V16.

c. When BT1 reads base pressure (≅ 0.00 T), record the reading.

d. Close V13, V15, and V16.

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[1] If the duct has a high/low flow sensor, increasing the air flow may cause an alarm condition, triggering the GAE interlock circuit. If necessary, bypass (jumper) the flow sensor. The interlock resets after clearing the alarm by a push-button on the rear of the vaccon unit or a remote customer provided push-button.

e. Manually close the *Process Gas Shutoff* valve on the outside of the GAE cabinet.

f. Turn off the roughing pump.

g. To switch off power to the solenoid valves, press the push-button switch labeled *Pneu Valve Shutdown* on the GAE cabinet so that the green light is off. Before continuing, be certain that the valves listed in the table below are in the specified state.

Table 1:

Valve	State
V12	Closed
V13	Closed
V14	Closed
V15	Closed
V16	Closed
V17	Closed (Off)
V20	Closed

Part 2. Secure the Carbon Cabinet

Configure the Carbon cabinet in the "safe" mode as follows.

2-1. Open the Carbon cabinet door and bypass the safety interlock shut-off switch on the door opening of the Carbon cabinet.

Bypass the switch with the cabinet door open by pulling the switch actuator toward you until it clicks into the extended by-pass position.

(Opening the cabinet door has the same effect as shutting off the Pneu Valve Shutdown switch: the dc power controlling the pneumatic valves is shut off. Bypassing the switch restores dc power to the pneumatic valves.)

2-2. Close the manual valve on the Carbon cylinder assembly by turning it 1/4 turn clockwise.

2-3. Gain access to the Carbon Gas Control Popup dialogue box.

2-4. Close valves V31 through V36. To close valve V35, click on the valve icon to obtain the setpoint dialog box, then click on the *LeakValve* toggle button so that it reads *OFF.*

2-5. Click on the RP (FP for single pump systems) icon to turn on the roughing pump. Wait until TC1 reads ≤0.01 torr, then open valves V31, V32, and V33.

2-6. Wait for BT1 to read base pressure (≅ 0.00 T).

2-7. Close valves V31, V32, and V33, then turn off the roughing pump.

2-8. To switch off power to the solenoid valves, press the push-button switch labeled *Pneu Valve Shutdown* on the Carbon cabinet so that the green light is off. Before continuing, be certain that the valves listed in the table below are in the specified state.

Table 2:

Valve	State
V31	Closed
V32	Closed
V33	Closed
V34	Closed
V35	Closed (Off)
V36	Closed

Part 3. Secure the Siloxane Cabinet

Configure the SiO_2 cabinet in the "safe" mode as follows.

3-1. Access the Siloxane popup from the Misc menu, and proceed.

3-2. Close the manual 1/4-turn valve on the SiO_2 bottle assembly.

3-3. Using the Gas Control popup, close valves V41 through V46.

3-4. Turn on the rough pump; Wait until TC1 reads ≤0.01 torr, then open V43.

3-5. Wait for BT1 to read base pressure (≅ 0.00 T).

3-6. Close V53; turn off the rough pump.

3-7. To switch off power to the solenoid valves, press the push-button switch labeled *Pneu Valve Shutdown* on the SiO_2 cabinet so that the green light is off. Before continuing, be certain that the valves listed in the table below are in the specified state.

Table 3:

Valve	State
V41	Closed
V42	Closed
V43	Closed
V44	Closed
V45	Closed (Off)
V46	Closed
V19	Closed

Part 4. Secure the Oxygen Cabinet

Configure the O_2 cabinet in the "safe" mode as follows.

4-1. Access the Oxygen popup dialogue box and proceed.

4-2. Close the manual 1/4 turn valve on the O_2 bottle assembly.

4-3. Close valves V51 through V56.

4-4. Turn on the rough pump; Wait until TC1 reads ≤0.01 torr, then open V53.

4-5. Wait for BT1 to read base pressure (≅ 0.00 T).

4-6. Close V53; turn off the rough pump.

4-7. To switch off power to the solenoid valves, press the push-button switch labeled *Pneu Valve Shutdown* on the O_2 cabinet so that the green light is off. Before continuing, be certain that the valves listed in the table below are in the specified state.

Table 4:

Valve	State
V51	Closed
V52	Closed
V53	Closed (Off)
V54	Closed
V55	Closed
V56	Closed

Emergency contact: N/A

General comments: This oil is used in Varian V-1000 turbo pumps without ceramic bearings

This MSDS is provided for general information only. For information about the manufacturer of a particular chemical, contact the environmental health and safety coordinator at Micrion Corporation, 508-531-6464.

Manufacturer: Micanite and Insulators Co. LTD

Distributor: Biddle Instruments
510 Township Line Road
Blue Bell, PA 19422

Telephone: 215-646-9200

Varian Part No: 969-9901,2

Substance Identification

Substance: Apiezon A OilCAS# 64742-65-0

Trade names and synonyms: Varian Turbo T.A. Oil

Physical Data

Boiling point @760 mm Hg: >350° CSpecific gravity @ 20° C: 0.865

Vapor pressure: 3×10^{-6} mm Hg @30°C Evaporation Rate: Negligible

Solubility in H2O: insolubleAppearance and Odor: pale amber liquid, no odor

Fire and Explosion Data

Flash point: 210°C (IP 34)Extinguishing agents: Use carbon dioxide, dry powder, or dry sand.

Special Fire fighting procedures: NoneUnusual fire and explosion hazards: None

Health Hazard Data

Health Hazards: None knownCarcinogenicity: Not regulated

Signs and Symptoms of Exposure: None likely

Emergency first aid procedures: In case of accidental eye contact, flush with clean water. If ingested, do not induce vomiting, obtain medical attention.

Reactivity Data

Stable

Hazardous polymerization will not occur.

Spill or Leak Procedures

Wipe up or absorb with sand, earth, or sawdust. Do not wash directly into any public water or sewer system.

Waste Disposal Method

Dispose of according to local regulations for mineral oils.

Special Protection Information

Respiratory protection: None required.

Ventilation: Not required

Protective gloves: Not required.

Eye protection: Not required

Other protective clothing or equipment: Coverall recommended.

Washing/hygienic practices: Wash skin after contact and generally observe good standards of hygiene.

Special Precautions

Handling & storage precautions: None

Emergency contact: Chemtrec 800-424-9300

This MSDS is provided for general information only. For information about the manufacturer of a particular chemical, contact the environmental health and safety coordinator at Micrion Corporation, 508-531-6464.

Substance Identification

Chemical name: BromineChemical family: halogen

Formula: Br_2

Molecular weight: 159.81

CAS#: 7726-95-6

Physical Data

Dark red liquid

Boiling point: 59.5° CEvaporation rate: not available

Vapor pressure (mmHg): 175mm @ 20° CMelting point: —7.25° C
671mm @ 55° C

Vapor density (air = 1): 7.14Specific gravity: 3.102

Solubility in water: 3.6 gm per 100 ml @ 20° CAppearance: Dark red liquid

Health Hazard Data

Hazardous components:bromine (99 - 100%)

OSHA PEL: 8H

TWA: 0.7 mg/m^3

NIOSH REL: bromine-air 10HACGIH TLV: 2.5 mg/m^3
TWA: 0.1 PPMSTEL: 0.3 PPM

Routes of entry: inhalation, skin absorption, ingestion

Health hazards—acute and chronic: May be fatal if inhaled, swallowed, or absorbed through skin. Causes burns. Material is extremely destructive to tissue of the mucous membranes and upper respiratory tract, eyes, and skin. Inhalation may be fatal as a result of spasm, inflammation and edema of the larynx and bronchi, chemical pneumonitis and pulmonary edema.

Signs and symptoms of exposure: severe burns, coughing, wheezing, laryngitis, shortness of breath, headache, nausea, and vomiting.

Medical conditions generally aggravated by exposure: no data available

Emergency and first aid procedures:

Inhalation: remove victim to fresh air; if breathing is difficult, administer oxygen; if not breathing, give artificial respiration; consult a physician.

Ingestion: wash out mouth with water if victim is conscious; get Immediate medial attention; discard contaminated clothing and shoes. Eye Contact: flush with water for at least 15 minutes while removing contaminated clothing and shoes; assure adequate flushing by separating eyelids with fingers; obtain medical attention. Skin Contact: wash with soap; flush with water for 15 minutes.

Fire and Explosion Hazard Data

Flash point: does not flashFlammable limits: not applicable

Extinguishing media: noncombustible

Special fire fighting procedures: A self-contained breathing apparatus and full protective clothing should be worn when fighting fires. Prevent contact with skin and eyes.

Unusual fire and explosion hazards: strong oxidizing agent! Contact with other material may cause fire. Container explosion may occur under fire conditions.

Reactivity Data

Stability: unstable

Conditions to avoid: Contact with other material.

Incompatibility (materials to avoid): reducing agents, alkali metals, finely powdered metals, aluminum, corrodes steel, stainless steel, galvanized iron, copper, copper alloys, organic materials.

Hazardous decomposition or by-products: nature of decomposition products not known.

Precautions for Safe Handling and Use

If material is released or spilled: Evacuate area. Wear self-contained breathing apparatus and full protective equipment, such as a butyl rubber chemical proof air suit, with breathing air supplied. Cover with dry lime, sand, or soda ash. Place in covered containers. Wash the spill site after completing material pickup.

For handling and storing: Store in a cool, dry place, away from heat and direct sunlight. Keep container closed tightly. Avoid breathing vapors. Do not breathe vapor; do not get in eyes, on skin, or on clothing Avoid prolonged exposure. Harmful vapor; corrosive; lachrymator; highly toxic.

Other precautions: Do not store near, nor allow contact with, clothing and other combustibles.

Control Measures

Respiratory protection required: NIOSH-MSHA-approved respirator.

Ventilation: should be handled only in a fume hood or glove box.

Protective gloves: chemical resistant rubber or neoprene

Eye protection: 8 inch faceshield—minimum.

Other protective clothing or equipment: as required by your company

Work/hygienic practices: wash thoroughly after handling.

Emergency contact: 201-292-6250

General comments: Fomblin oil is used as pump lubricant in Varian chemical series mechanical pumps, such as the SD450, used as the fore and roughing pumps on Micrion 9000 and 8000 series FIB systems.

This MSDS is provided for general information only. For information about the manufacturer of a particular chemical, contact the environmental health and safety coordinator at Micrion Corporation, 508-531-6464.

Manufacturer: Montefluos S.P.A.

Importer/Distributor: Ausimont
44 Whippany Road
Morristown, NJ 07960

Substance Identification

Substance: Perfluorinated PolyethersCAS#: 69991-67-9

Trade names and synonyms: Fomblin Y 25/6 LVACChemical Family: Fluorocarbons

Molecular formula: $CF_3 - [(O-CF_3-CF_2)_n - (O-CF_2)_m] -O-CF_3$
CF_3

Hazardous Ingredients

None

Physical Data

Solubility in H2O: insolubleAppearance and odor: colorless and odorless

Distillation Range: 10-90% @ 0.5 torr: 190-290° CSpecific gravity: 1.9

Vapor Pressure: $<5 \times 10^{-6}$ mmHg @ 20° C

Fire and Explosion Data

Flash point: none

Fire fighting procedures: Keep containers cool by spraying with water when exposed to fire; if flames have reached product causing a possible decomposition yielding toxic compounds, use self contained breathing apparatus.

Unusual fire and explosion hazards: None

Health Hazard Data

Threshold limit value: NoneSymptoms of overexposure: No evidence, chronic or acute

Carcinogenicity: None

First Aid Procedures: Inhalation-n/a

Eyes: Clean and wash with water

Skin: Clean with water and soap

Ingestion: Induce vomiting

Reactivity Data

Conditions to avoid: avoid heating above 290° C

Incompatibility: Strong or non-aqueous alkali and Lewis acids above 100° C

Hazardous decomposition products: HF and COF_2 as the main components from thermal decomposition in air; both are Toxic.

HF - Hydrogen Fluoride has a TLV/TWA=2.5 mg/m^3; COF_2-Carbonyl Fluoride has TLV/TWA=5 mg/m^3

Hazardous Polymerization: None

Special Protection Information

Respiratory protection: None requiredVentilation: None required

Protective gloves: Suggested, not requiredEye protection: none required

Other protective equipment/clothing: Not required, follow internal area requirements

Special Precautions

Handling & storage precautions: For packaging and transport, use either bottles of drums of glass or polyethylene; do not store near flammable or explosive materials.

Other precautions: Keep away from fire, heat sources or hot surfaces; no smoking is compulsory in working areas. Avoid contamination of tobacco products.

Spill or Leak Procedures

Eliminate free flames from the area; stop the leak and absorb the liquid with sand and send to disposal.

Waste disposal methods: Landfill according to local, state or federal regulations or neutralize using high-temperature pyrolysis in special equipment asking producer for advice.

Emergency contact: Chemtrec 800-424-9300

General comments: The fire, explosion, and reactivity data given herein are derived from sources that address the hazards incurred in storing and handling large quantities, whereas a relatively small amount is used in this application.

Substance Identification

Generic name: Gallium ingotCAS Registry Number: 7440-55-3

Chemical Formula: Ga%Active: 100%

Physical Data

Physical description: Odorless grey metal or silvery liquid.

Percent volatiles by weight: 0Boiling point: subl. 2403° C

Melting point: 29.78° C Vapor pressure @ 20° X (mmHg): essentially 0

Specific gravity: 5.907 (6.09 liquid)Solubility in water: Insoluble

Fire and Explosion Hazard Data

Flash point: not applicable

Extinguishing agents: material does not burn or burns with difficulty. Do not use water or halogenated agents to extinguish a surrounding fire.

Fire fighting procedures: Leave area unless fitted with NIOSH/MSHA approved self-contained breathing apparatus, flame and chemical resistant clothing. hats, boots, and gloves.

Unusual fire & explosion hazards: None

Health Hazard Data

Hazardous exposure levels: no data

Effects of overexposure: no data

Emergency & first aid procedures: Eye contact: Flush eyes including under eyelids with large amounts of water for at least 15 minutes and seek medical attention. Skin Contact: Flood skin with large amounts of water; may cause dermatitis; if irritation persists, seek medical attention. Inhalation: Seek medical attention. Ingestion: Seek medical attention; may cause gastrointestinal disturbances.

Reactivity Data

Stability: air and moisture stable.

Conditions to avoid: reaction with alkalies (which evolves hydrogen and may ignite in contact with chlorine or bromine). Contact with aluminum causes embrillement.

Incompatible materials: strong oxidizing agents, strong acids, strong bases, halogens, and active metals

Hazardous decomposition products: carbon monoxide, carbon dioxide, hydrogen fluoride, organic fumes and platinum salts.

Hazardous Polymerization: none

Spill or Leak Procedures

If material is released or spilled: wearing full protective equipment, cover with dry sad or vermiculite and sweep up.

Waste disposal method: Follow federal, state, and local regulations.

Special Protection Information

Respiratory Protection: NIOSH/MSHA approved mask with organic vapor cartridge; for emergency use NIOSH/MSHA approved self-contained breathing apparatus.

Ventilation: High efficiency particle respirator; laboratory fume hood; provide adequate local exhaust and general ventilation.

Protective gloves: Yes.

Eye protection: chemical safety goggles or face shield.

Other protective equipment: none special.

Emergency contact: Chemtrec 800-424-9300

This MSDS is provided for general information only. For information about the manufacturer of a particular chemical, contact the environmental health and safety coordinator at Micrion Corporation, 508-531-6464.

Substance Identification

Substance: OxygenChemical Family: Oxidizer

Trade names and synonyms: NoneChemical Formula: 0_2

DOT Hazard Class: Nonflammable gasDOT Identification Number: UN 1072

CAS Number: 7782-44-7

Health Hazard Data

Time Weighted Average Exposure Limit:

None established. Oxygen is the vital element in the atmosphere in which we live and breathe (approximately 21 molar% of the atmosphere).

Symptoms Of Exposure:

Breathing high concentrations greater that (75 molar percent) causes symptoms of hyperoxia which included cramps, nausea, dizziness, hypothermia, ambylopia, respiratory difficulties, bradycardia, fainting spells and convulsions capable of leading to death. For additional information on hyperoxia, see Compressed Gas Association's Pamphlet P-14.

Toxicological Properties:

The property is that of hyperoxia which leads to pneumonia. Concentrations between 25 and 75 molar percent present a risk of inflammation of organic matter in the body.

First aid procedures:

PROMPT MEDICAL ATTENTION IS MANDATORY IN ALL CASES OF OVEREXPOSURE TO OXYGEN.

RESCUE PERSONNEL SHOULD BE COGNIZANT OF FIRE HAZARD ASSOCIATED WITH OXYGEN-RICH ATMOSPHERES.

Conscious persons should be assisted to an uncontaminated area and breathe fresh air. They should be kept warm and quiet. The physician should be informed that the victim is experiencing (has experienced) hyperoxia.

Unconscious persons should be moved to an uncontaminated area and given assisted respiration. when breathing has been restored, treatment should be as above. Continued treatment should be symptomatic and supportive.

Physical Data

Boiling Point: -297.3°F (-182.90°C)

Liquid Density @ Boiling Point: 71.23 lb./ft.^{3} (1141 kg./m^3)

Vapor Pressure @ 700F (21.10C): Above the critical temperature. of -l8l.10F (-118.40C)

Specific Gravity ~ 700F, 1 atm. (air=1): 1.11

Solubility in Water: Slightly soluble

Freezing Point: -361.80F (-218.80C)

Appearance and Odor: Colorless odorless gas.

Fire/Explosion Hazards Data

Flash Point (Method Used): N/A

Auto Ignition Temperature: N/A

LEL: N/A

UEL: N/A

Extinguishing Media: Copious quantities of water for fires with oxygen as the oxidizer.

Electrical Classification: Nonhazardous

Special Fire Fighting Procedures: If possible, stop the flow of oxygen which is supporting the fire.

Unusual Fire and Explosion Hazards: Vigorously accelerates combustion.

Reactivity Data

Hazardous Mixtures of Other Liquids, Solids, or Gases:

Oxygen vigorously accelerates combustion. Contact with all flammable materials should be avoided. Some materials which are not flammable in air will burn in pure oxygen or oxygen—enriched atmospheres.

Stability: Stable

Incompatibility (Materials to Avoid): All flammable materials

Hazardous Decomposition Products: None

Hazardous Polymerization: Will not occur

Conditions to Avoid:

Spill or Leak Procedures

Steps to Be Taken in Case Material Is Released or Spilled:

Evacuate all personnel from affected area. Use appropriate protective equipment. If leak is in user's equipment, be certain to purge piping with an inert gas prior to attempting repairs. If leak is in container or container valve, contact CHEMTREC for emergency assistance or your closest Airco location.

Waste Disposal Method:

Do not attempt to dispose of waste or unused quantities. Return in the shipping container properly labeled~ with any valve outlet plugs or caps secured and valve protection cap in place to Airco for proper disposal.

Special Protection Information

Respiratory Protection: N/A

Ventilation: To prevent accumulation above 25 molar percent.

Local Exhaust: To prevent accumulation of high concentrations so as to reduce the oxygen level in the air to less than 18 molar percent.

Special:

Mechanical (Gen.):

Other:

Protective Gloves: Any material.

Eye Protection: Safety goggles or glasses.

Other Protective Equipment: Safety shoes, safety shower.

Special Precautions

Special Labeling Information:

DOT Shipping Name: Oxygen or Oxygen compressed
DOT Shipping Label: Oxidizer
DOT Hazard Class: Nonflammable Gas I.D. No.: UN 1072

Special Handling Recommendations:

Use only in well-ventilated areas. Valve protection caps must remain in place unless container is secured with valve outlet piped to use point. Do not drag, slide or roll cylinders. Use a suitable band truck for cylinder movement. Use a pressure reducing regulator when connecting cylinder to lower pressure (3000 psig) piping or systems. Do not heat cylinder by any means to increase the discharge rate of product from the cylinder. Use a check valve or trap in the discharge line to prevent hazardous back flow into the cylinder.

For additional handling recommendations, consult Compressed Gas Association Pamphlets P-l, P-14, and G-4. NFPA #51-1984, OSHA 1910-Subparts H & Q

Special Storage Recommendations:

Protect cylinders from physical damage. Store in cool, dry, well—ventilated area away from heavily trafficked areas and emergency exits. Do not allow the temperature where cylinders are stored to exceed l3OF (54C). Cylinders should be stored upright and firmly secured to prevent falling or being knocked over. Full and empty cylinders should be segregated. Use a “first in—first out” inventory system to prevent full cylinders being stored for excessive periods of time. Post “No Smoking or Open Flames” signs in the storage or use area. There should be no sources of ignition in the storage or use area.

For additional recommendations, consult Compressed Gas Association Pamphlets P-l, P-14, and G-4. NFPA #51-1984, OSHA 1910 - Subparts H & Q

Special Packaging Recommendations:

Carbon steels and low alloy steels are acceptable for use at lower pressures. For high pressure applications use stainless steels, copper and its alloys, nickel and its alloys, brass, bronze, silicon alloys, Monel^{R}, Incone^{R} or beryllium. lead and silver or lead and tin alloys are good gasketing materials. Teflon^{R} and Kel-F^{R} are the preferred nonmetal gaskets.

Special Note: It should be recognized that the ignition temperature of metals and nonmetals in pure oxygen service decreases with increasing oxygen pressure.

Other Recommendations or Precautions:

Oxygen should not be used as a substitute for compressed air in pneumatic equipment since this type generally contains flammable lubricants. Equipment to contain oxygen must be “cleaned for oxygen service”. See Compressed Gas Association Pamphlet G-4.l. Compressed gas cylinders should not be refilled except by qualified producers of compressed gases. Shipments of a compressed gas cylinder, which has not been filled by the owner or with his (written) consent, is a violation of Federal Law (49CFR).

Emergency contact: Chemtrec 800-424-9300

General comments: The fire, explosion, and reactivity data given herein are derived from sources that address the hazards incurred in storing and handling large quantities, whereas a relatively small amount is used in this application.

Substance Identification

Generic name: platinum (II) hexafluoroacetylacetonateCAS Registry Number: 65353-51-7

Chemical formula: $Pt(CF_3COCHCOCF_3)_2$Molecular Wt: 609.22

Physical Data

Physical description: orange xtl.

Percent volatiles by weight: no dataBoiling point: subl. 65°/0.1mm

Melting point: (143-145° dec)Vapor pressure @ 20° X (mmHg): no data

Specific gravity: no dataSolubility in water: Insoluble

Fire and Explosion Hazard Data

Flash point: no data

Extinguishing agents: carbon dioxide or dry powder

Fire fighting procedures: Leave area unless fitted with NIOSH/MSHA approved self-contained breathing apparatus, flame and chemical resistant clothing. hats, boots, and gloves.

Unusual fire & explosion hazards: None

Health Hazard Data

Hazardous exposure levels: no data

Effects of overexposure: no data

Emergency & first aid procedures: Eye contact: Flush with running water for 15 minutes, get medical attention immediately. Skin Contact: Remove any contaminated clothing; wash exposed areas thoroughly with soap and water for at least five minutes. Inhalation: Remove the victim to fresh air and seek medical attention if coughing, shortness of breath or irritation persists. Ingestion: Give the victim plenty of water and seek medical assistance.

Reactivity Data

Stability: air and moisture stable.

Conditions to avoid: none.

Incompatible materials: oxidizing agents and active metals

Hazardous decomposition products: carbon monoxide, carbon dioxide, hydrogen fluoride,

organic fumes and platinum salts.

Hazardous Polymerization: none

Spill or Leak Procedures

If material is released or spilled: sweep up.

Waste disposal method: Follow federal, state, and local regulations.

Special Protection Information

Respiratory Protection: NIOSH/MSHA approved mask with organic vapor cartridge; for emergency use NIOSH/MSHA approved self-contained breathing apparatus.

Ventilation: Provide adequate local exhaust and general ventilation.

Protective gloves: Yes.

Eye protection: chemical safety goggles or face shield.

Other protective equipment: none special.

Emergency contact: Chemtrec 800-424-9300

General comments: The fire, explosion, and reactivity data given herein are derived from sources that address the hazards incurred in storing and handling large quantities of styrene, whereas a relatively small amount (30 ml) is used in this application.

Substance Identification

Generic name: styreneChemical class: hydrocarbon

Trade names & synonyms: vinylbenzene; styrene monomer; phenylethylene; HC1

Chemical formula: $C_6H_5CH=CH_2$ %Activity: 100%

Physical Data

Physical description: Colorless to light yellow oily liquid. Detectable at low concentrations by a sweet, possibly pleasant odor. Odor may be pungent and unpleasant at high concentrations. Odor is detectable at 0.15 ppm in air; fatigue may raise this threshold in some individuals.

Percent volatiles by weight: 100%Boiling point: 293° F (145° C)

Melting point: -23° F (-31° C)Vapor pressure @ 20° X (mmHg): 5.6 torr

Specific gravity: 0.909 @ 20° CSolubility in water: Insoluble

Fire and Explosion Hazard Data

Flash point: 88° F (31° C)Autoignition point: 914° F (490° C)

Flammability limits in air: 1.1% - 6.1% by volume.

Extinguishing agents: Use carbon dioxide, foam, chemical extinguishing agents, sand, or dolomite. Water may be ineffective.

Fire fighting procedures: Wear NIOSH/MSHA approved self-contained breathing apparatus, flame and chemical resistant clothing. hats, boots, and gloves. If without risk, remove material from fire area. Cool container with water from maximum distance.

Unusual fire & explosion hazards: Gives off acrid fumes when heated. Reacts violently with oxidizers, catalysts for vinyl polymers, peroxides, strong acids, aluminum chloride.

Health Hazard Data

Threshold limit value: 50 ppm

Hazardous exposure levels: Breathing the vapor in a concentration of 10,000 ppm for 30 minutes has resulted in human fatality. A dose of 5,000 mg per kg of body weight given orally has been fatal to 50% of laboratory rats tested. A dose of 90 mg per kg of body weight given by intravenous injection has been fatal to 50% of laboratory mice tested. (ref: NIOSH/RTECS 1981-82) Has been determined to be carcinogenic in experimental mice.

Effects of overexposure: Can cause irritation, violent itching and watering of the eyes and severe

human eye injury. Acute overexposure results in possible drowsiness or narcosis.

Emergency & first aid procedures: Eye contact: Flush with running water for 15 minutes, get medical attention immediately. Skin Contact: Remove any contaminated clothing; wash exposed areas thoroughly with soap and water, get medical attention if irritation persists or if exposure is extensive. Ingestion: Do not induce vomiting! Get medical help immediately. Inhalation: Remove to fresh air; keep warm and at rest; if not breathing, administer artificial respiration; if breathing difficult, administer oxygen; get medical help.

Reactivity Data

Stability: Stable in storage below 90° F. Polymerization may occur if heated above 150° F.

Conditions to avoid: Avoid exposure to heat, spark, flames, and incompatible materials.

Incompatible materials: Reacts readily with oxidizing agents, peroxides, strong acids, aluminum chloride, catalysts for vinyl polymers.

Hazardous decomposition products: Toxic gases and vapors given off when partially oxidized.

Hazardous Polymerization: May polymerize if heated above 150° F or exposed to metal salts, peroxides, or strong acids. Polymerization not considered hazardous in this application due to small quantity involved.

Spill or Leak Procedures

If material is released or spilled: Wearing full protective clothing and respiratory protection, eliminate all sources of ignition. Cover spill with dry sand or dry vermiculite, mix well, and carefully transfer to a well-marked container. Close container tightly. Submit or retain for disposal.

Waste disposal method: Follow federal, state, and local regulations.

Special Protection Information

Respiratory Protection: NIOSH/MSHA approved mask with organic vapor cartridge; for emergency use NIOSH/MSHA approved self-contained breathing apparatus.

Ventilation: Provide adequate local exhaust and general ventilation to meet the 50 ppm TLV requirements.

Protective gloves: Impervious rubber.

Eye protection: chemical safety goggles or face shield.

Other protective equipment: Lab coat & apron, flame & chemical resistant coveralls, eyewash capable of sustained flushing, safety drench shower & hygienic washing facility.

Emergency contact: Chemtrec 800-424-9300

This MSDS is provided for general information only. For information about the manufacturer of a particular chemical, contact the environmental health and safety coordinator at Micrion Corporation, 508-531-6464.

Substance Identification

Chemical name: Tetraethoxysiloxane Chemical family: Organosilane

Formula: $(CH_3\,CH_2O)4Si$Molecular weight: 208.331

CAS#: 75-10-4

Physical Data

Clear, colorless liquid; alcohol-like odor% volatile by volume: 100%

Boiling point: 169° CEvaporation rate: >1

Vapor pressure @ 20° C: n/aMelting point: -85° C

Vapor density (air = 1): 1Specific gravity: 0.9335

Solubility in water: insoluble, reacts slowly

Health Hazard Data

Routes of entry: inhalation, skin absorption, ingestion

Emergency and first aid procedures: Inhalation: remove victim to fresh air; if breathing is difficult get immediate medical attention. Ingestion: get Immediate medial attention. Eye Contact: flush with plenty of water for at least 15 minutes; get medical attention. Skin Contact: remove contaminated clothing; immediately flush with water for at least 15 minutes; get medical attention.

Fire and Explosion Hazard Data

Flash point: 116° FFlammable limits: not established

Extinguishing media: dry chemical, carbon dioxide, foam or sand.

Special fire fighting procedures: A self-contained breathing apparatus and full protective clothing should be worn when fighting fires.

Reactivity Data

Stability: stable

Conditions to avoid: exposure to moisture

Incompatibility (materials to avoid): water, acids, bases, oxidizers.

Hazardous decomposition or by-products: carbon monoxide, carbon dioxide, silicon dioxide.

Hazardous polymerization: will not occur

Precautions for Safe Handling and Use

If material is released or spilled:Evacuate the area; eiliminate ignition sources; keep unprotected personnel out of area; use self-contained breathing apparatus and appropriate PPE; cover spill with sand, vermiculite or other dry absorbent; place in disposable containers; ventilate area before re-entering.

Disposal: Incinerate in accordance with regulations.

For handling and storing: Store in cool, dry, well-ventilated area; keep container sealed; use appropriate PPE; avoid skin contact and avoid breathing vapors.

Control Measures

Respiratory protection required: NIOSH/OSHA-approved organic vapor respirator.

Ventilation: use process enclosures, local exhaust ventilation or other engineering controls to reduce airborne concentrations.

Protective gloves: rubber or neoprene

Eye protection: safety glasses or chemical splash goggles

Other protective clothing or equipment: as required by your company

Work/hygienic practices: handle in a fume hood; wash after handling; keep exposures below TLV/PEL.

Emergency contact: Chemtrec 800-424-9300

This MSDS is provided for general information only. For information about the manufacturer of a particular chemical, contact the environmental health and safety coordinator at Micrion Corporation, 508-531-6464.

Substance Identification

Chemical name: 2, 4, 6, 8 Tetramethylcyclotetrasiloxane Chemical family: Silicones

Formula: $C_4H_{16}O_4Si_4$Molecular weight: 240.51

CAS#: 2370-88-9

Physical Data

Clear, colorless liquid; ether-like odor% volatile by volume: 100%

Boiling point: 135° CEvaporation rate: <1

Vapor pressure @ 20° C: 7 torrFreezing point: -65° C

Vapor density (air = 1): >8Specific gravity: 0.991

Solubility in water: insoluble

Health Hazard Data

Routes of entry: inhalation, skin absorption, ingestion

Health hazards (acute and chronic): irritated skin, lungs, and eyes.

Medical conditions generally aggravated by exposure:

Emergency and first aid procedures:

Inhalation: remove victim to fresh air; if breathing is difficult administer oxygen; administer artificial repsiration if not breathing; get immediate medical attention.

Ingestion: If conscious, rinse mouth with water, induce vomiting; get immediate medial attention.

Eye Contact: flush with plenty of water for at least 15 minutes; get medical attention.

Skin Contact: remove contaminated clothing; immediately flush with water for at least 15 minutes; get medical attention.

Fire and Explosion Hazard Data

Flash point: 24° CFlammable limits: not established

Extinguishing media: dry chemical, carbon dioxide, foam or sand; for large fires, flood area with water.

Special fire fighting procedures: A self-contained breathing apparatus and full protective clothing should be worn when fighting fires.

Unusual fire and explosion hazards: flammable liquid; contained vapors may create a hazard for fire or explosion; may emit toxic or irritating gases upon combustion.

Reactivity Data

Stability: stable

Conditions to avoid: exposure to moisture

Incompatibility (materials to avoid): water, alcohols, silanols, or other hydroxyl-containing compounds in the presence of a catalyst (e.g., acids, bases, polar salts, heavy metals).

Hazardous decomposition or by-products: Silica, carbon monoxide, carbon dioxide, organic pyrolysis products, hydrogen gas.

Hazardous polymerization: will not occur

Precautions for Safe Handling and Use

If material is released or spilled: Isolate hazardous area; eiliminate moisture and ignition sources; keep unprotected personnel out of area; use self-contained breathing apparatus and appropriate PPE; cover spill with sand, vermiculite or other dry absorbent.

For handling and storing: Store in cool, dry, well-ventilated area; keep container sealed; use appropriate PPE; avoid skin contact and avoid breathing vapors.

Control Measures

Respiratory protection required: NIOSH/OSHA-approved respirator.

Ventilation: use process enclosures, local exhaust ventilation or other engineering controls to reduce airborne concentrations.

Protective gloves: rubber or neoprene

Skin protection: when chemical contact is possible, wear impervious gloves, splash apron, work uniform and shoes or coverlets.

Eye protection: safety glasses or chemical splash goggles

Other protective clothing or equipment: as required by your company

Work/hygienic practices: wash after handling.

Emergency contact: Chemtrec 800-424-9300

General comments: The fire, explosion, and reactivity data given herein are derived from sources that address the hazards incurred in storing and handling large quantities, whereas a relatively small amount is used in this application.

Substance Identification

Generic name: tungsten carbonylCAS Registry Number: 14040-11-0

Chemical formula: $W(CO)_6$Molecular Wt: 351.92

Physical Data

Physical description: white xtl.

Percent volatiles by weight: no dataBoiling point: no data

Melting point: (169-170° dec)Vapor pressure @ 20° X (mmHg): no data

Specific gravity: no dataSolubility in water: Insoluble

Fire and Explosion Hazard Data

Flash point: no data

Extinguishing agents: carbon dioxide or dry powder

Fire fighting procedures: Leave area unless wearing NIOSH/MSHA approved self-contained breathing apparatus, flame and chemical resistant clothing. hats, boots, and gloves.

Unusual fire & explosion hazards: None

Health Hazard Data

Hazardous exposure levels: no data

Effects of overexposure: no data

Emergency & first aid procedures:

Eye contact: Flush with running water for 15 minutes, get medical attention immediately.

Skin Contact: Remove any contaminated clothing; wash exposed areas thoroughly with soap and water for at least five minutes.

Inhalation: Remove the victim to fresh air and seek medical attention if coughing, shortness of breath or irritation persists.

Ingestion: Give the victim plenty of water and seek medical assistance.

Reactivity Data

Stability: air and moisture stable.

Conditions to avoid: none.

Incompatible materials: oxidizing agents and halogens

Hazardous decomposition products: carbon monoxide.

Hazardous Polymerization: none

Spill or Leak Procedures

If material is released or spilled: sweep up.

Waste disposal method: Follow federal, state, and local regulations.

Special Protection Information

Respiratory Protection: NIOSH/MSHA approved mask with organic vapor cartridge; for emergency use NIOSH/MSHA approved self-contained breathing apparatus.

Ventilation: Provide adequate local exhaust and general ventilation.

Protective gloves: Yes.

Eye protection: chemical safety goggles or face shield.

Other protective equipment: none special.

Emergency contact: Chemtrec 800-424-9300

This MSDS is provided for general information only. For information about the manufacturer of a particular chemical, contact the environmental health and safety coordinator at Micrion Corporation, 508-531-6464.

Substance Identification

Chemical name: xenon difluorideChemical family: inorganic fluoride

Formula: XeF_2Molecular weight: 169.3

CAS#: 13709-36-9

Physical Data

White solid, bleach smell

Boiling point: not availableEvaporation rate: not available

Vapor pressure (mmHg): 3.8Melting point: 140° C

Vapor density (air = 1): >1Specific gravity: not available

Solubility in water: decomposes

Health Hazard Data

Hazardous components: xenon difluoride (99 - 100%), xenon tetrafluoride (0 - 1%)

OSHA PEL: 2.5 mg/m^3ACGIH TLV: 2.5 mg/m^3

Regulated under SARA 313?: No

Routes of entry: inhalation, skin absorption, ingestion

Health hazards (acute and chronic): To the best of our knowledge, the toxicity of this material has not been determined. May be harmful if inhaled, ingested, or absorbed by skin. Will cause severe irritation to skin, eyes and mucous membranes of the upper respiratory system. Not known to be carcinogenic.

Signs and symptoms of exposure: coughing, difficulty breathing, burning eyes and nose.

Medical conditions generally aggravated by exposure: no data available

Emergency and first aid procedures:

Inhalation: remove victim to fresh air; if breathing is difficult, administer oxygen; consult a physician.

Ingestion: Give milk; get Immediate medial attention.

Eye Contact: flush with water for at least 15 minutes; obtain medical attention.

Skin Contact: wash with soap; flush with water for at least 15 minutes.

Fire and Explosion Hazard Data

Flash point: does not flashFlammable limits: not applicable

Extinguishing media: not applicable

Special fire fighting procedures: A self-contained breathing apparatus and full protective clothing should be worn when fighting fires.

Unusual fire and explosion hazards: potent oxidizing agent!

Warning: Raman spectroscopy of this material indicates that races of xenon tetrafluoride are present. When exposed to moisture, xenon tetrafluoride may form xenon trioxide, a potentially dangerous explosive.

Reactivity Data

Stability: unstable

Conditions to avoid: exposure to air

Incompatibility (materials to avoid): air, moisture, most organics

Hazardous decomposition or by-products: fluorine, fluoride

Hazardous polymerization: will not occur

Precautions for Safe Handling and Use

If material is released or spilled: Evacuate area. Wear self-contained breathing apparatus and full protective equipment. Cautiously neutralize with caustic and water. Cover with lime. Add absorbent material and put into a disposal container.

For handling and storing: Store under an inert atmosphere. Keep container closed tightly. Avoid breathing vapors. Avoid all skin contact.

Other precautions: Keep away from moisture. Do not store with organics or reducing agents.

Control Measures

Respiratory protection required: OSHA-approved respirator.

Ventilation: should be handled only in a fume hood or glove box.

Protective gloves: rubber or neoprene

Eye protection: safety glasses or chemical splash goggles

Other protective clothing or equipment: as required by your company

Work/hygienic practices: wash after handling.

Section 3: Stage

- 03-01A Checking the Stage Travel-Limit Switches
- 03-01B Adjusting the Stage Travel-Limit Switches
- 03-02 Stage Lead Screw Inspection and Lubrication
- 03-03 Stage Mapping (Not included)
- 03-04 *Mic_Stage* Program Stage Accuracy
- 03-05 Laser Beam Alignment
- 03-06 Stage Height and Carrier Flatness Measurement
- 03-07 Clamp Actuator Inspection

Micrion

Service Procedure No.: **03-01A**
Service Procedure Title: **Checking the Stage Travel Limit Switches**
Applicable Systems: **8000, Micrion 9800 FlipChip, MicroMill HT**
Frequency of Service: **Annually**

Introduction

This procedure describes how to check the travel limit switches associated with the stage. These switches include:

- X and Y axis

This checking procedure may be performed while the system is under vacuum, and while the beam is powered up.

In the event that you need to adjust or replace any limit switch, see Service Procedure 03-01B.

This procedure refers to Service Procedure 09-03, Using vacchat.

Part 1. Zeroing the Stage to Test the Negative Limit Switches

Zero the stage to test the negative limit (nlimit) switches in the x and y axes, and to verify the encoder readback. See Fig. 1 for the location of the x and y axes limit switches, and the load limit switch.

1-1. To make sure the Readback function is turned on, toggle the *Readback* button on the *Tasks* pulldown.

1-2. To access the *Stage Control* popup, click on the *Stage* icon.

1-3. Click on the *Zero Stage* button to zero the stage.

1-4. Check the screen interface to see if the encoder verifies the stage is at 0, 0.

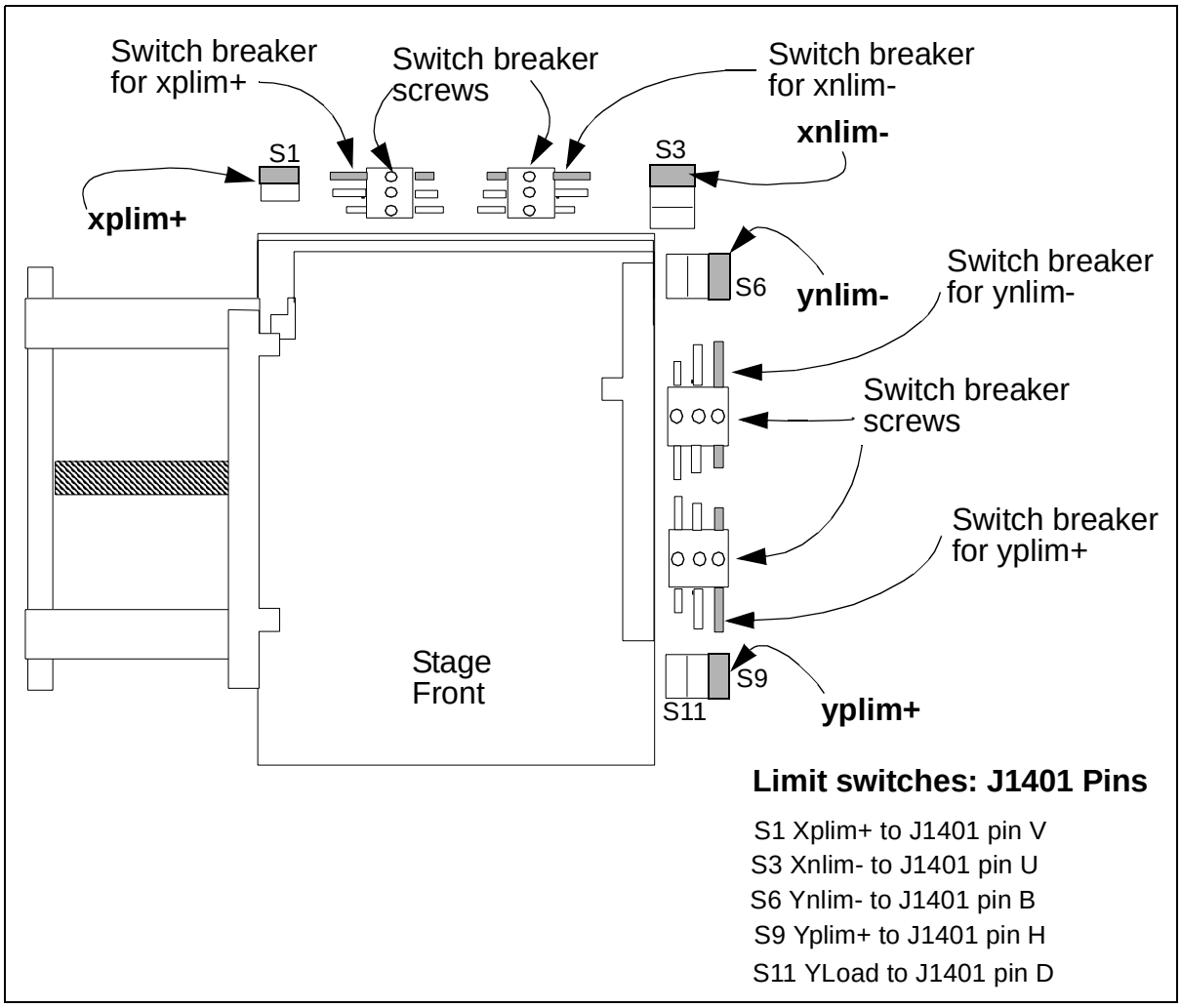


Figure 1. Stage Travel Limit Switches

1-5. In an xterm window, begin the *motorshell* program.

1-6. In the *motorshell* program, type:

```
>xstage
```

1-7. At the *xstage* prompt, type:

```
>read_nlimit
```

The following message indicates that the plimit switch has been actuated:

```
hex: 1 dec: 1
```

If not 1, this may indicate a problem with the limit switch.

1-8. Repeat steps 1-6 and 1-7 by typing the name of another axis, and reading the nlimit switch status.

Part 2. Checking Any Limit Switch

To check the x and y limit switches, you can exercise the stage motors. The following numbered procedure is to be used along with Table 1.

2-1. In an xterm window, begin the *motorshell* program.

2-2. Type the name of the axis whose limit switches you want to check.

2-3. Type the `move` command to move the stage in the positive direction.

2-4. When the stage stops moving, check the *Stage* popup.

2-5. In *motorshell*, type the `read_plimit` command

The following message indicates that the plimit switch has been actuated:

```
hex: 1 dec: 1
```

Table 1: Checking the Limit Switch Readbacks with Motorshell

Axis	Command Sequence	Stage Position (on *Microsurgery* screen)	`Read_nlimit`	`Read_plimit`
xstage	move stop move - stop	150000 +/- 2000 µm 0 µm	 1	1
ystage	move stop move - stop	150000 +/- 2000 µm 0 µm	 1	1

Micron

Service Procedure No.: **03-01B**
Service Procedure Title: **Adjusting the Stage Limit Switches**
Applicable Systems: **8000, Micron 9800 FlipChip, MicroMill HT**
Frequency of Service: **As necessary**

Introduction

This procedure explains how to adjust or replace a limit switch that proved faulty during Service Procedure 03-01A. These switches include:

- X and Y

Materials Required

These procedures require the use of the following materials and equipment:

- Standard field service engineer's tool set
- Clean-room gloves

This procedure refers to Service Procedure 09-03, Using *Vacchat*.

Notice

Per paragraph 11.1 of Safety Guidelines for Semiconductor Manufacturing Equipment (S2-93), this procedure is a Type 3 task. Specifically: "Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are less than 30 volts RMS, 42.2 volts peak, 240 volt-amps, and 20 Joules."

Part 1. System Preparation

Configure the Chemical Sources in "Safe" Mode

Before performing the tasks described in this procedure, you must put the chemical sources in a "safe" mode; see Service Procedure 02-01.

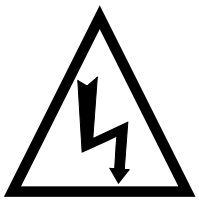
WARNING

Do not proceed until the chemical sources are secure. The chemical reservoirs in FIB systems contain hazardous materials. Labels affixed to the exterior of a chemical cabinet identify the chemical(s) contained inside. If a chemical source is not in its "safest" state, as described in **Service Procedure 02-01**, it is possible for a combination of component failures to release the chemical(s) through a cabinet's delivery line, a roughing line, a purging line, or from the tungsten reservoir into the workchamber. Do not open the workchamber, or disassemble any part of the vacuum pumping system, or detach any gas line from any chemical cabinet until you are sure that every chemical source attached to the FIB system is in its "safest" state.

Power Down and Vent the System

Before performing the tasks described in this procedure, you must power down and vent the system; see Service Procedure 01-02.

WARNING



Dangerously high voltages are present in the process module while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and auto procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

Open the Workchamber

Remove the front panels to access the workchamber door.

Once the system is completely vented, open the workchamber door by removing the socket-head cap screws and releasing the KF clamp connecting the roughing line to the loadlock.

FRAGILE

With the workchamber door open, several pieces of delicate equipment are exposed. Take great care not to disturb the gas delivery systems and deposition nozzles, the electron flood gun, and the microchannel plate (MCP), all of which are located at or near the bottom of the ion beam column.

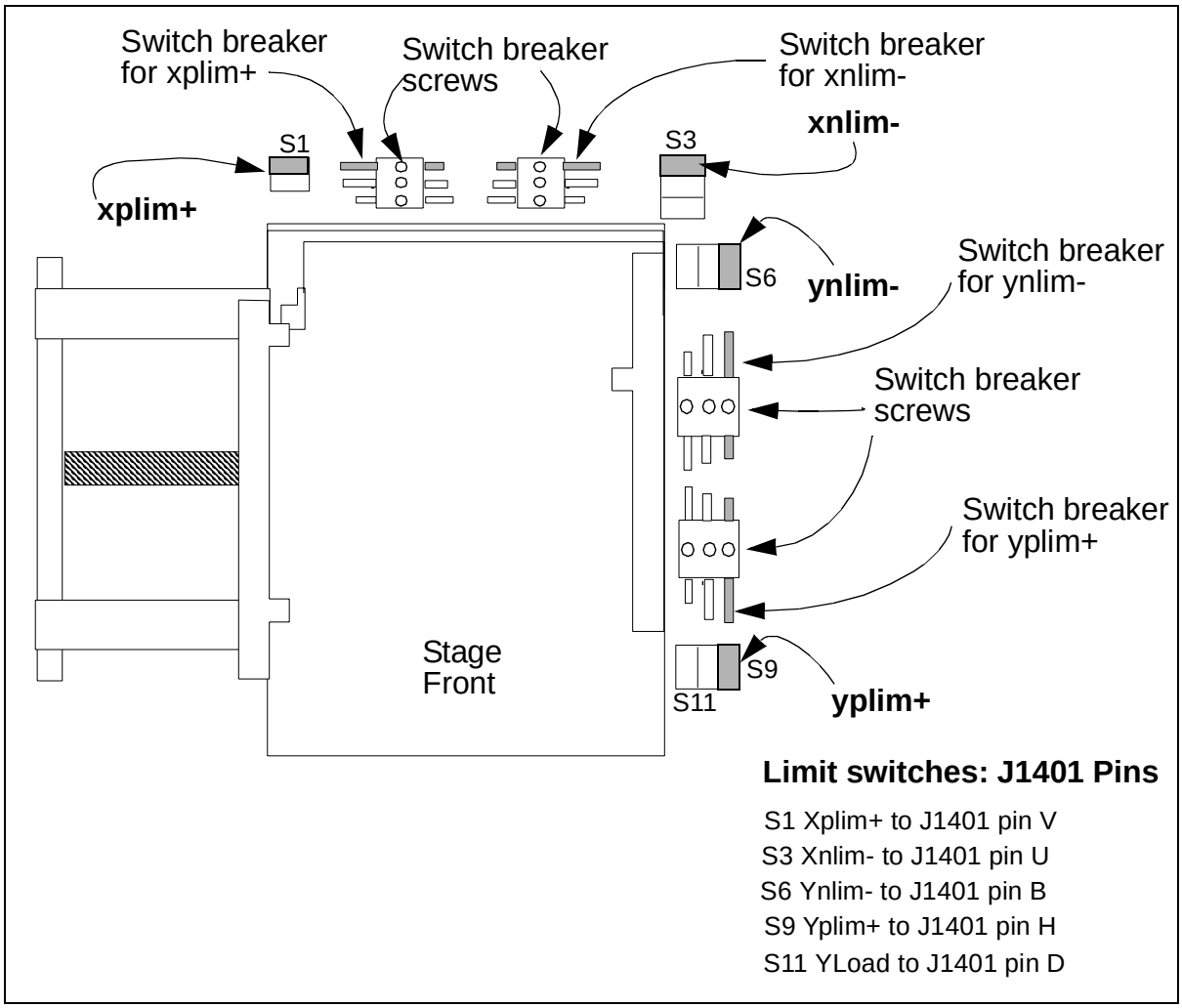


Figure 1. Stage Travel Limit Switches

Part 2. Adjusting X and Y Limit Switches

If in comparison with Table 1 in Service Procedure 3-1A, the x or y limit positions change more than 2000 μm, adjust the appropriate limit switch. See Fig. 1. Directions given in Table 1 are as shown in Fig. 1.

Table 1: Adjusting X and Y Limit Switches

IF	THEN loosen the closest switch breaker screws and :
Xplim+ greater than 150000 +2000 μm	Move the switch breaker to the left
Xplim+ less than 150000 -2000 μm	Move the switch breaker to the right
Xnlim- greater than 0 +2000 μm	Move the switch breaker to the left
Xnlim- less than 0 -2000 μm	Move the switch breaker to the right
Yplim+ greater than 150000 +2000 μm	Move the switch breaker down
Yplim+ less than 150000 +2000 μm	Move the switch breaker up
Ynlim- greater than 0 +2000 μm	Move the switch breaker down
Ynlim- less than 0 -2000 μm	Move the switch breaker up

Micron

Service Procedure No.: **03-02**
Service Procedure Title: **Stage Lead Screw Inspection & Lubrication**
Applicable Systems: **8000, Micron 9800 FlipChip, MicroMill HT**
Frequency of Service: **Every Six Months**

Introduction

The stage assembly consists of plates that move at right angles to each other by means of lead screws. Proper lubrication of the lead screws ensures reliable operation of the stage. This procedure should be done only as needed. Too much lubricant can interfere with proper performance of the stage.

This procedure provides details on:

- The components of the stage that require lubrication
- The type of lubrication required
- Where and how to apply the lubrication

Materials Required

This procedure requires the use of the following materials and equipment:

- Standard field service engineer's tool set
- Clean-room gloves
- Lint-free wipes
- Braycote 602 black vacuum grease
- Braycote 803 white vacuum grease

NOTICE

Per paragraph 11.1 of Safety Guidelines for Semiconductor Manufacturing Equipment (S2-93), this procedure is a Type 3 task. Specifically: "Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are less than 30 volts RMS, 42.2 volts peak, 240 volt-amps, and 20 Joules."

Part 1. System Preparation

Configure the Chemical Sources in "Safe" Mode

Before performing the tasks described in this procedure, you must put the chemical sources in a "safe" mode; see Service Procedure 02-01.

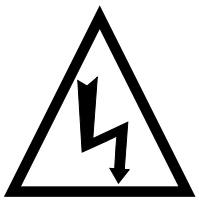
WARNING

Do not proceed until the chemical sources are secure. The chemical reservoirs in FIB systems contain hazardous materials. Labels affixed to the exterior of a chemical cabinet identify the chemical(s) contained inside. If a chemical source is not in its "safest" state, as described in **Service Procedure 02-01**, it is possible for a combination of component failures to release the chemical(s) through a cabinet's delivery line, a roughing line, a purging line, or from a chemical reservoir into the workchamber. Do not open the workchamber, or disassemble any part of the vacuum pumping system, or detach any gas line from any chemical cabinet until you are sure that every chemical source attached to the FIB system is in its "safest" state.

Power Down and Vent the System

Before performing the tasks described in this procedure, you must power down the high voltages and vent the system; see Service Procedure 01-02.

WARNING



Dangerously high voltages are present in the process module while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and automatic procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

Open the Workchamber

Remove the front panels to gain access to the workchamber cover. When the system is completely vented, remove the 1/2" socket-head cap screws and open the workchamber.

WEAR GLOVES, DO NOT HANDLE SOLVENTS

When working inside the chamber or when handling any components that will be exposed to vacuum, wear gloves rated for Class 100 environments or better. Due to disintegration of such gloves by solvents, do not handle solvents or parts that are wet with solvent.

Part 2. Lubricate the X-Axis Lead Screw

Whenever possible, move the stage by means of the *Motorshell* program or by using the stage icons in the application program. It is also possible to move the stage manually by rotating the x-axis lead screw from outside the workchamber with a 3/8" box wrench. Be sure to wear clean-room gloves, and to rotate the lead screw as close to the stage housing as possible.

2-1. In an xterm window, start the *Motorshell* program by typing:

```
motorshell
```

2-2. Prepare to move the stage in the x-axis by typing the command:

```
xstage
```

2-3. To move the stage to the right (as shown in Figures 1 and 2) type:

```
move-
```

See Figures 1 and 2 for the location of the x-axis lead screw in relation to the stage.

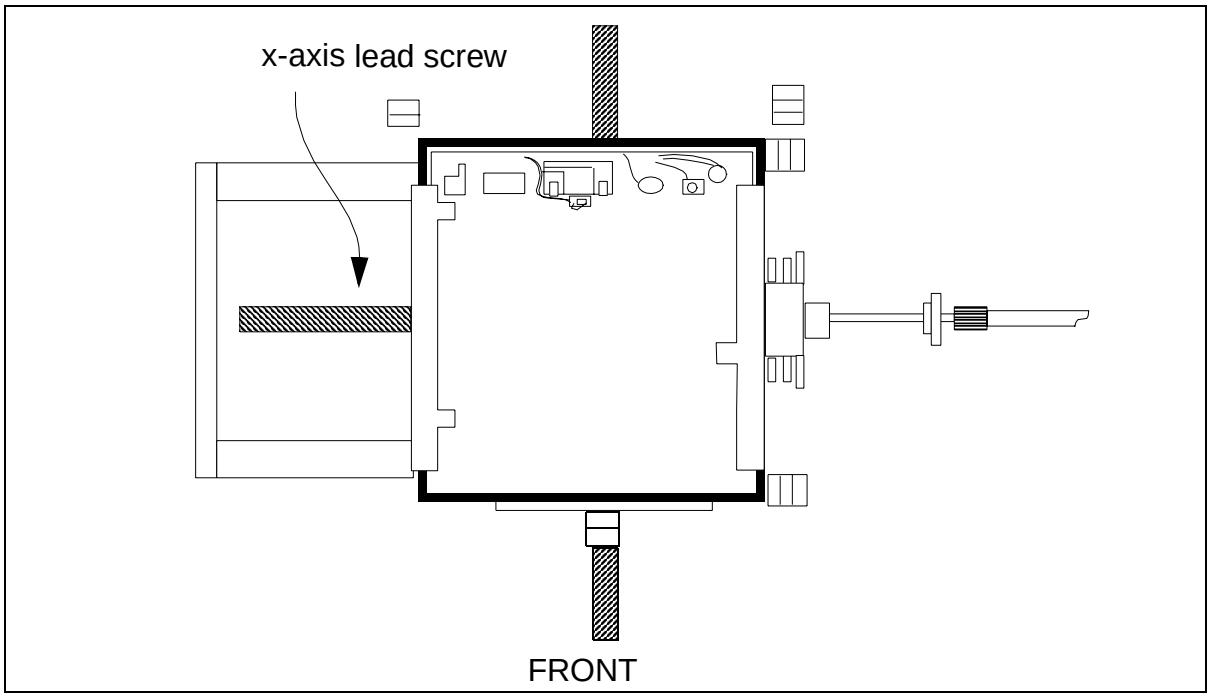


Figure 1. Top View of the Stage for the 8000 or the 9800 FlipChip

2-4. If there are deposits of old lubricant on the x-axis drive shaft, use lint-free wipes to remove the old lubricant.

2-5. Lubricate the x-axis lead screw with a small amount of Braycote 602 black vacuum grease. DO SO VERY GENTLY.

2-6. Make sure that stage movement is not impeded by any hardware or maintenance materials. Work the lubricant in by moving the stage back and forth in the x direction with the following *motorshell* commands:

```
move
move-
```

Apply additional lubricant (a bead at a time) and work it in as necessary.

2-7. Remove the excess lubricant in the area where the lead screw meets the housing beneath the stage.

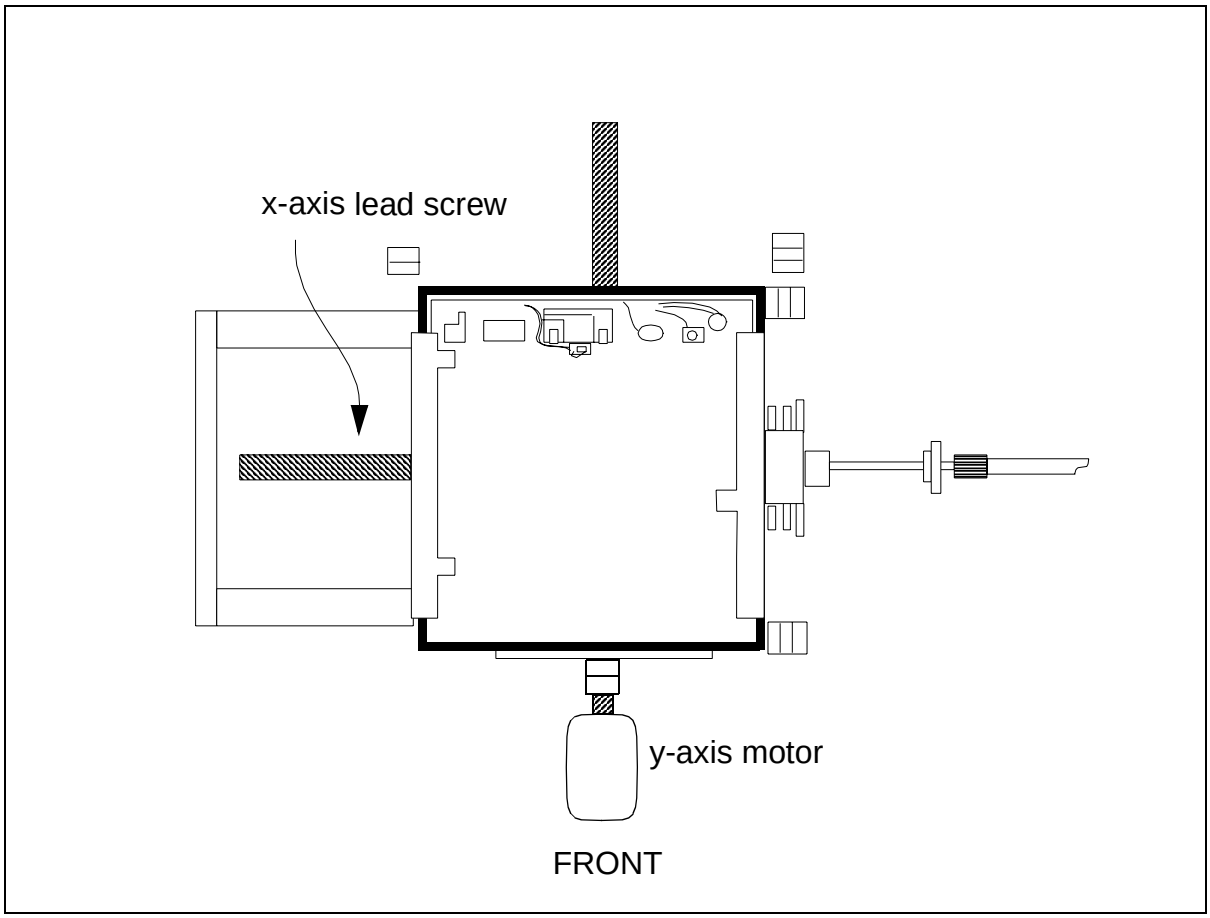


Figure 2. Top View of the MicroMill HTStage

Part 3. Lubricate the Y-Axis Lead Screw

Whenever possible, move the stage by means of the *Motorshell* program or by using the stage icons in the application program. However, it is also possible to move the stage manually by rotating the x-axis lead screw from outside the workchamber with a 3/8" box wrench. Be sure to wear clean-room gloves, and to rotate the lead screw as close to the stage housing as possible.

NOTICE: Lead Screws are easily damaged.

Manually rotate the lead screws as close to the stage housing as possible**.**

3-1. With the motorshell program running in an xterm window (see step 2-1), prepare to move the stage in the y-axis with the *motorshell* command:

```
ystage
```

3-2. To move the stage to the front (as shown in Figures 1 and 2) type:

```
move
```

3-3. If there are deposits of old lubricant on the y-axis drive lead screws, use lint-free wipes to remove the old lubricant. DO SO VERY GENTLY.

3-4. Lubricate the y-axis drive shaft with a small amount of Braycote 602 black vacuum grease.

3-5. Make sure that stage movement is not impeded by any hardware or maintenance materials. Work the lubricant in by moving the stage back and forth in the y direction with the following *motorshell* commands:

```
move-
```

```
move
```

Apply additional lubricant (a bead at a time) and work it in as necessary.

3-6. Remove the excess lubricant in the area where the lead screw meets the housing beneath the stage.

Part 4. Lubricate the Clamp Actuator Gears

The clamp actuator gears, described in Service Procedure 03-07, are underneath the workchamber, just behind the vibration isolator in the front of the process module (see Figure 3). One of the gears is at the end of the horizontal air cylinder, and the other gear is at the end of the vertical cam shaft.

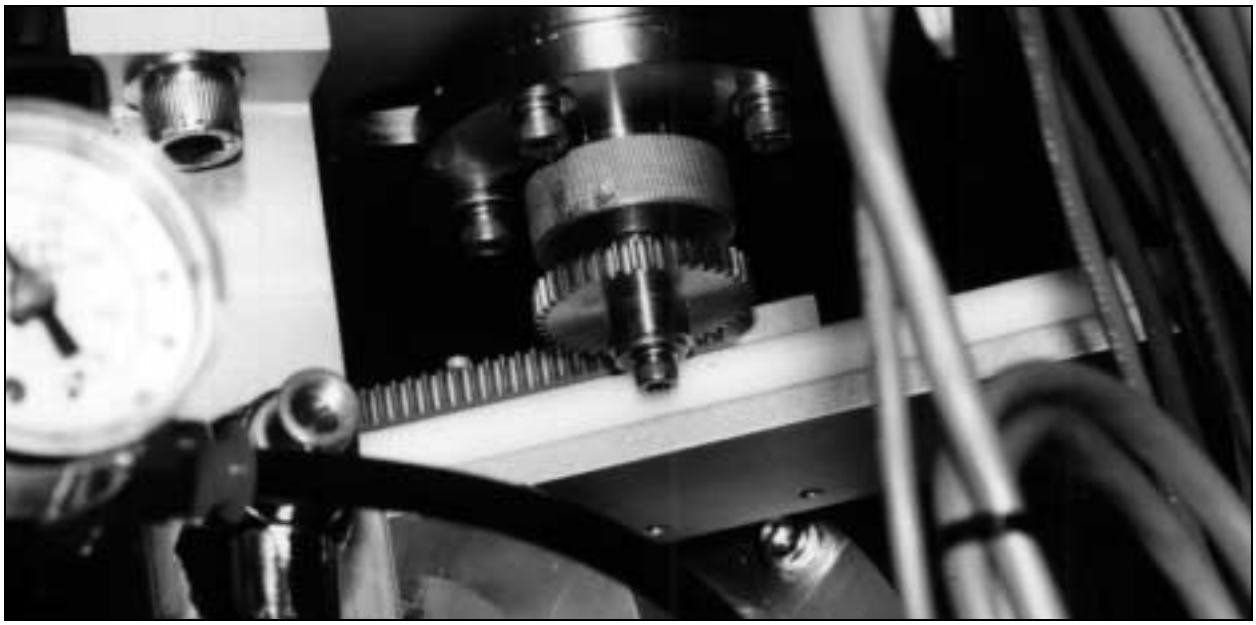


Figure 3. Clamp Actuator Gears Beneath Workchamber

4-1. Remove any old grease from the gears with a lint-free wipe dabbed with alcohol.

4-2. Apply fresh Braycote 803 white vacuum grease all the way around each gear.

NOTE: All automated programs no longer work in vacserver. This includes autovent, autopumpdown, and calabrate functions. This is a temporary situation and will be changed back in the next release of software.

4-3. To distribute the grease over the gears, turn the gears with the *vacserver* commands `cac` and `cau`, to clamp and unclamp the work sample on the stage.

Micrion

Service Procedure No.: **03-04**
Service Procedure Title: **Mic_Stage Program for Stage Accuracy**
Applicable Systems: **8000, Micrion 9800 FlipChip**
Frequency of Service: **Once before shipment; again if necessary**

Introduction

Mic_stage is a Micrion program for testing stage accuracy. This test should be run once before shipment of the product, and again if there is a question about the accuracy of the stage. The testing procedure involves locating die points on a known grid, and saving their X and Y offsets to a file.

If you observe a large X/Y offset (> 5 μm) for most of the the points, check the following :

- Die Size
- Rotation Value

The most critical element is the rotation value of the mask or wafer. To calculate rotation value, see Part 2.

Materials Required

This procedure requires the following items:

- Reticle (a die grid on the mask or wafer) with known specifications
- *Mic_stage* program (in the /tmp directory; configuration file: *mic_stage_config)*
- System calibrated for deflection (see Pan Rotation/Ortho Calibration in Service Procedure 07-05)

Part 1. Loading and Specifying a Known Reticle (Mask or Wafer)

Using the *Mask Repair* or *Microsurgery* program, load a reticle into system.

1-1. Open a new xterm window and type: `mic_stage`.

A small popup window with two buttons will appear at the top left corner of the screen.

1-2. Click on the top button, *StageTest*.

The main window *Micrion Stage Accuracy* appears. This window contains four subwindows:

a. *Reticle*

b. *CurrentPoint*

c. *Others*

d. The die grid

1-3. In the *Mask Repair* or *Microsurgery* window, move the stage until the lower left corner of the patterned die reticle appears in the field of view. This corner is the test origin.

1-4. In the Micrion Stage Accuracy window, fill in the fields in the *Reticle* subwindow:

`DieSize X/Y (mm)` (As specified for the reticle)

`DieArray Col/Row` (As specified for the reticle)

`DieOrigin X/Y (mm) (`Click the *Read* button.)

`MaskRotation (deg) (`See Part 2.)

1-5. Carefully adjust the stage so that the lower left corner is located exactly in the center of the field of view. (Use the *Center* function.)

1-6. Click the *Apply* button.

Part 2. Calculating Mask/Wafer Rotation

There are three ways to measure the rotation value of the mask or wafer.

1. Use the 'Lock Window' feature to lock the reticle origin point and a second point on the same horizontal line. The 'Lock Window' feature will show you the rotation value. (See the Operator's manual for Coordinate Lock Popup details.)
2. Move the reticle origin point to the screen center. Use a relative move to move the stage to a point that has coordinates (X', Y'), where (X'=10 times the die size in μm) and (Y' = 0.00). Measure the value of the y-offset, which is the distance between the reticle edge to the screen center. Use the arctan function to calculate the rotation value:

   MaskRotation:(deg) = arctan(y-offset/X')

3. Use the *MTMR* button in the *Reticle* subwindow. 'MTMR' means Measure The Mask Rotation. Follow directions in 'Help' for proper use of this section.

Part 4. Generating an Offset for Each Selected Point

If the die patterned reticle is a 10-row by 10-column mask or wafer, for the best calibration you need to test 10 x 10 = 100 separate points. (You can always test fewer points to get a general idea of the stage accuracy.) For each selected point, do as follows:

4-1. In the Die Grid subwindow, click on the lower left corner of the reticle. This is the origin of the test. Each die cell origin is at the lower left corner of its die cell.

In the *CurrentPoint* subwindow, the following data about the point is displayed:

Col/Row:	(The current point you have selected above)
X/Y Location:	(The theoretical stage address of current point)

You can edit the *mic_stage_config* file to correct any of these specifications.

4-2. In the lower part of the *Mask Repair* window, click the button that raises the funnel.

4-3. In the *CurrentPoint* subwindow, click the *GoTo* button. The stage will move to the theoretical location of the current point.

4-4. In the lower part of the *Mask Repair* window, click the button to lower the funnel.

4-5. In *Mask Repair* or *Microsurgery,* image the current point after stage has moved into position. There may be a X/Y offset between image (real position) of the current point and the screen center (theoretical position of the current point).

4-6. Move stage until the current point image is located in the screen center.

4-7. In the *Micrion Stage Accuracy* window, click the *Read* button. At this point the 'X/Y Offset' between theoretical and real current point values is displayed.

4-8. When you click the *Set* button, the system calculates the X/Y offset; a yellow circle is displayed at that point in the Die Grid if the offset is < 5.0 μm, or a red circle is displayed if the offset is > 5.0 μm.

Part 5. Generating a Report of All Offsets

5-1. After testing all points, click the *Report* button in the *Others*[1] subwindow. This saves all offset data to the *test_results.dat* file.

---

[1] In the *Others* subwindow, the *LoadData* button reads the data stored in the *test_results.data* file. The *3D-Report* button generates a 3D graphic in the Die Grid subwindow, in which the tested points are displayed.

Part 6. Loading Data from the *mic_stage_config* File

You can load data from the *mic_stage_config* file. Contents of *mic_stage_config* are as follows:

Table 1:

Field	Format	Description
DIESIZE	Floating point: xsize (μm) and ysize (μm)	Real size of the die on the test reticle
DIECOLROW	Col_integer and Row_integer	Number of columns and rows on the test reticle
DIEPIXEL	DiePix_integer	Size of the die in the graphics Die Grid subwindow
ERRORPIXEL	ErrPix_integer	Controls conversion for error radius displayed. units are pixel/ μm
ERRORLIMIT	ErrLim_integer	Controls the size vs. color of error circle drawn; units are μm
DUMPFILE	*test_results.dat*	Controls the name of the file in which the test results are saved

Micron

Service Procedure No.: **03-05**
Service Procedure Title: **Laser Alignment**
Applicable Systems: **8000, Micrion 9800 FlipChip, MicroMill HT**
Frequency of Service: **As Needed**

Introduction

Some FIB systems are equipped with Laser IF stage location systems. This procedure describes how to align the laser system so that it indicates stage motion accurately.

Materials Required

This procedure requires the use of the following materials and equipment:

- Standard field service engineer's tool set
- Clean-room gloves
- Lint-free wipes
- Laboratory-grade isopropyl alcohol
- Dial indicator, Federal Corp. LT-150 or equivalent, accurate to 0.00005" (1.28 μm)
- Adjustable dial indicator stand
- A second person to help with the alignment
- HP laser target(s)
- HP laser alignment aid tool

This procedure refers to Service Procedure 06-03, Workchamber Inspection and Cleaning, 03-01, Stage Travel Limit Switch Inspection, and 01-02, Power Down, Vent, and Reset.

NOTICE

Per paragraph 11.1 of Safety Guidelines for Semiconductor Manufacturing Equipment (S2-93), this procedure is a Type 3 task. Specifically: "Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are less than 30 volts RMS, 42.2 volts peak, 240 volt-amps, and 20 Joules."

Part 1. System Preparation

Configure the Chemical Sources in "Safe" Mode

Before performing the tasks described in this procedure, you must put the chemical sources in a "safe" mode; see Service Procedure 02-01.

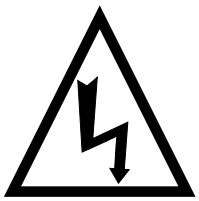
WARNING

Do not proceed until the chemical sources are secure. The chemical reservoirs in FIB systems contain hazardous materials. Labels affixed to the exterior of a chemical cabinet identify the chemical(s) contained inside. If a chemical source is not in its "safest" state, as described in **Service Procedure 02-01**, it is possible for a combination of component failures to release the chemical(s) through a cabinet's delivery line, a roughing line, a purging line, or from a chemical reservoir into the workchamber. Do not open the workchamber, or disassemble any part of the vacuum pumping system, or detach any gas line from any chemical cabinet until you are sure that every chemical source attached to the FIB system is in its "safest" state.

Power Down and Vent the System

Before performing the tasks described in this procedure, you must power down and vent the system; see Service Procedure 01-02.

WARNING



Dangerously high voltages are present in the process module while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and automatic procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

Open the Workchamber

Remove the front panels to gain access to the workchamber door.

When the system is completely vented, open the workchamber lid by removing the 1/2" socket head cap screws.

WEAR GLOVES, DO NOT HANDLE SOLVENTS

When working inside the chamber or when handling any components that will be exposed to vacuum, wear gloves rated for Class 100 environments or better. Due to disintegration of such gloves by solvents, do not handle solvents or parts that are wet with solvent.

CAUTION

The laser incorporated in the FIB System is a Class 2 (low power) laser. Eye damage can result if you look directly into the beam or into a specular (mirror-like) reflection of it. Do not stare into the beam or into a specular reflection of it.

Remove the Column

You must remove the column in order to gain access to the reference mirror adjustment screws[1]; see service procedure 05-09-05 (for a 5 nm column), 05-09-10 (for a 10 nm column), or 05-09-25 (for a 25 nm column).

[1] If you are reasonably certain that the positions of the reference mirrors have not been altered, it may not be necessary to remove the column and adjust the reference mirrors in order to perform a successful alignment.

Part 2. Stage Mirror Alignment

Note: An indication of stage mirror alignment can be obtained by using a multimeter to check the voltage at the pins on the back of the receiver(s) while moving the stage to its positive and negative limits (in x and y). A lack of change in output voltage indicates that the stage mirrors are fairly well aligned.

2-1. Using the *motorshell* program, move the stage to its positive x limit. Service Procedure 03-01, Stage Travel Limit Switch Inspection, describes how to use the *motorshell* program to move the stage. It is also possible to move the stage by turning the ends of the x and y drive motor shafts (outside of the workchamber) by hand or with a 3/8" box wrench, but it is recommended that you use the *motorshell* program to move the stage.

2-2. Figure 1 shows the position of the x-axis stage mirror within the workchamber. Figure 2 shows the side view of the x-axis stage mirror. Note that there is a scribe line near the bottom of the mirror. The laser beams make contact with the area of the mirror above the scribe line; **this surface must not be scratched or damaged in any way.** The area below the scribe line is not contacted by the laser beams; this is the area of the mirror that will be used (with the dial indicator) to check the stage mirror alignment.

2-3. Use the adjustable dial indicator stand to position the dial indicator near the side of the x-axis stage mirror (see Figure 1). Adjust the height of the dial indicator stand so that the dial indicator will make contact with the area of the x-axis stage mirror **below the scribe line.** See Figure 2.

NOTICE: KEEP THE DIAL INDICATOR BELOW THE SCRIBE LINE

The area of the stage mirror above the scribe line must not be scratched or damaged in any way. Avoid contacting this area; keep the dial indicator below the scribe line.

2-4. Carefully move the dial indicator against the x-axis stage mirror until its dial begins to move. "Zero" the dial indicator by moving it so that its dial is aligned with one of the divisions (lines) on the dial indicator's gauge.

2-5. Move the stage back and forth in the y direction (using the *motorshell* program, or by turning the end of the y-axis drive motor shaft) while observing the dial indicator's gauge. The dial indicator reading should not vary by more than 0.00005" (1.28 μm) over the entire length (at the level of the scribe line) of the x-axis stage mirror.

2-6. If the dial indicator reading varies by more than 0.00005", use the stage mirror adjustment screws (shown in Figure 2) to adjust the position of the x-axis stage mirror. Begin with minimal rotation (less than one turn) of the stage mirror adjustment screws; even a small adjustment may result in a significant change in stage mirror alignment. Repeat step 2-5. Repeat the x-axis stage adjustment until the dial indicator reading is within specification.

2-7. Repeat the alignment procedure for the y-axis stage mirror.

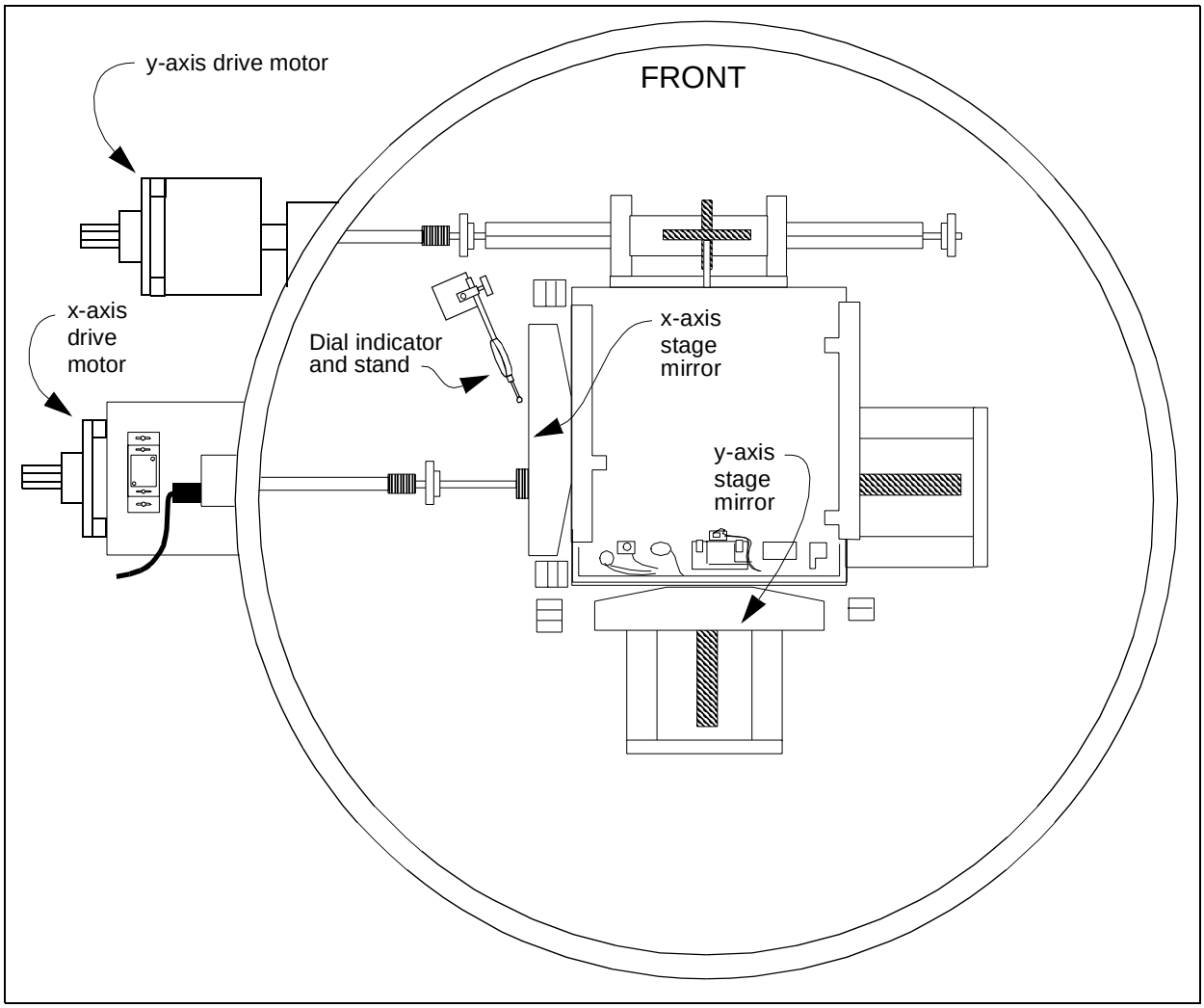


Figure 1. Top View of the Workchamber and Stage Mirrors (Lid Open)

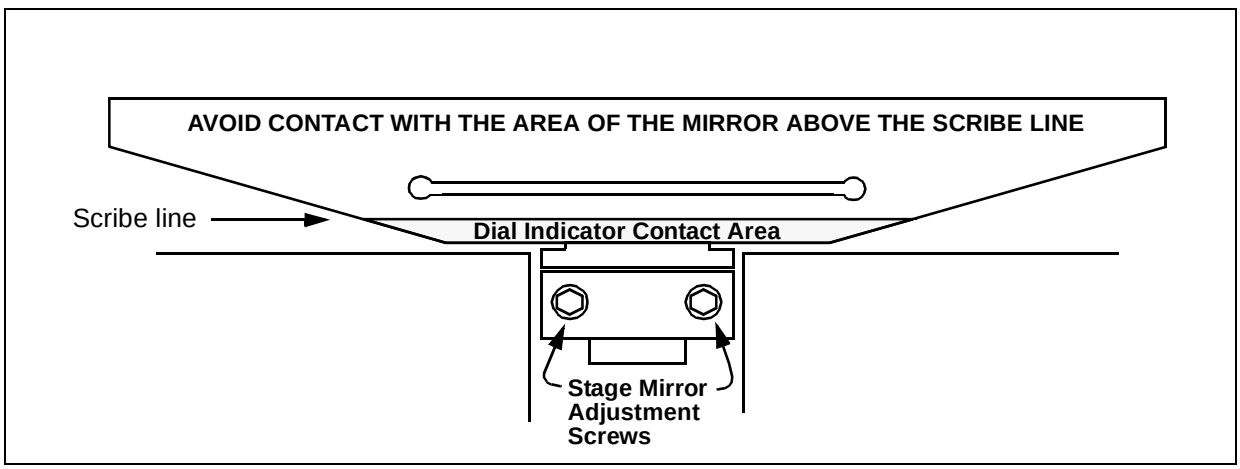


Figure 2. Side View of Stage Mirror

Part 3. Interferometer Alignment

Each interferometer should be flush against the workchamber and centered within its mounting slot (see Figure 3).

3-1. Inspect each interferometer (see Figure 4 for the location of the x and y interferometers).

3-2. If an interferometer is not properly aligned, loosen its mounting screws, adjust the position of the interferometer so that it is flush against the workchamber and centered within its mounting slot, then retighten the screws (see Figure 3).

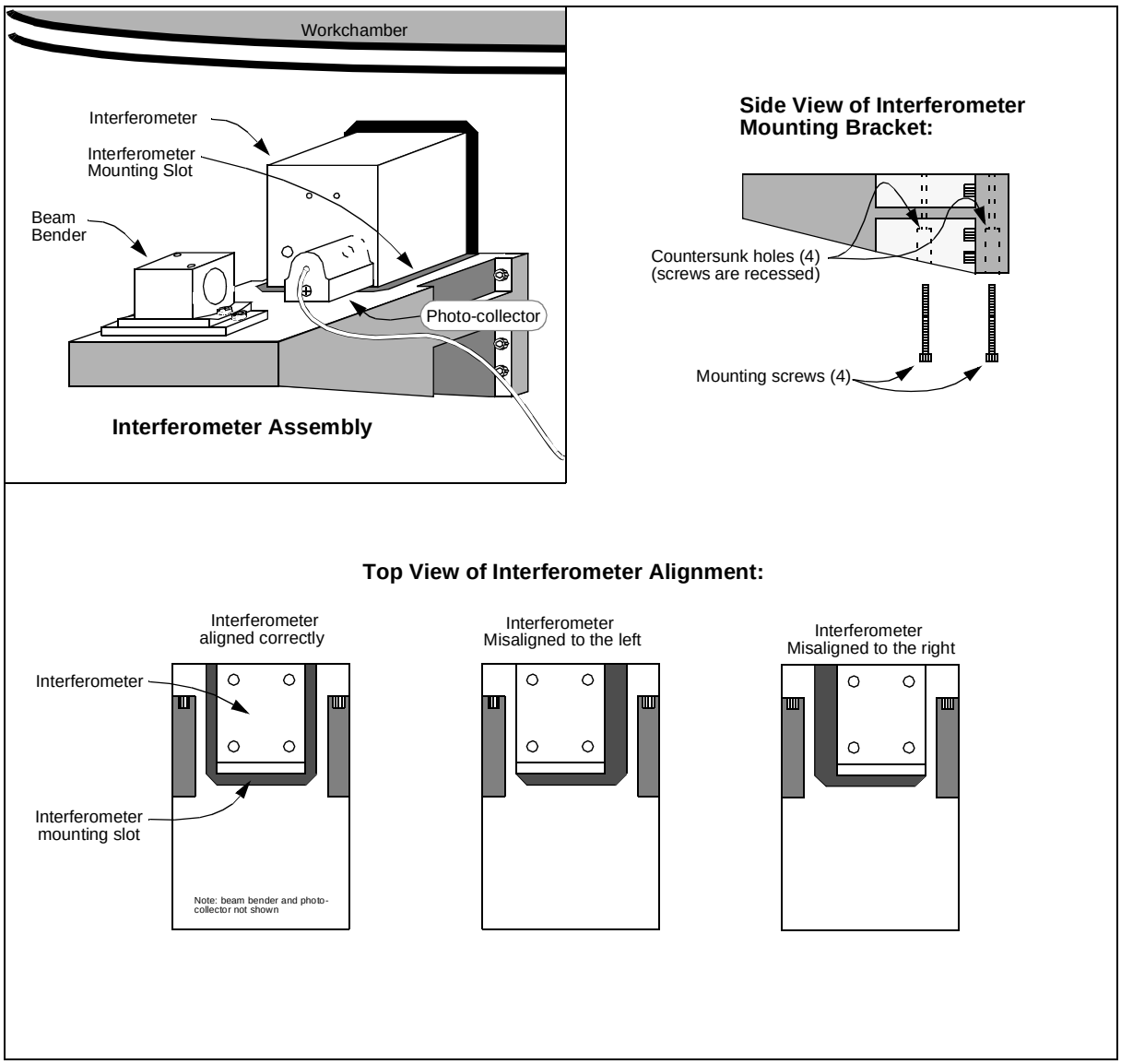


Figure 3. Top and Side Views of Interferometer

Part 4. Laser Alignment

Close the Workchamber

The workchamber must be closed in order to perform the laser alignment procedure; close the workchamber lid and tighten the "T" screw on the front of the lid (so that the switch block on the lid actuates the switch on the top right of the workchamber).

4-1. Using the *motorshell* program, move the stage to the left front corner of the workchamber (as viewed from the front of the workchamber). Service Procedure 03-01, Stage Travel Limit Switch Inspection, describes how to use the *motorshell* program to move the stage. It is also possible to move the stage by turning the ends of the x and y drive motor shafts (outside of the workchamber) by hand or with a 3/8" box wrench, but it is recommended that you use the *motorshell* program to move the stage. See Figure 4 for the location of the laser system components.

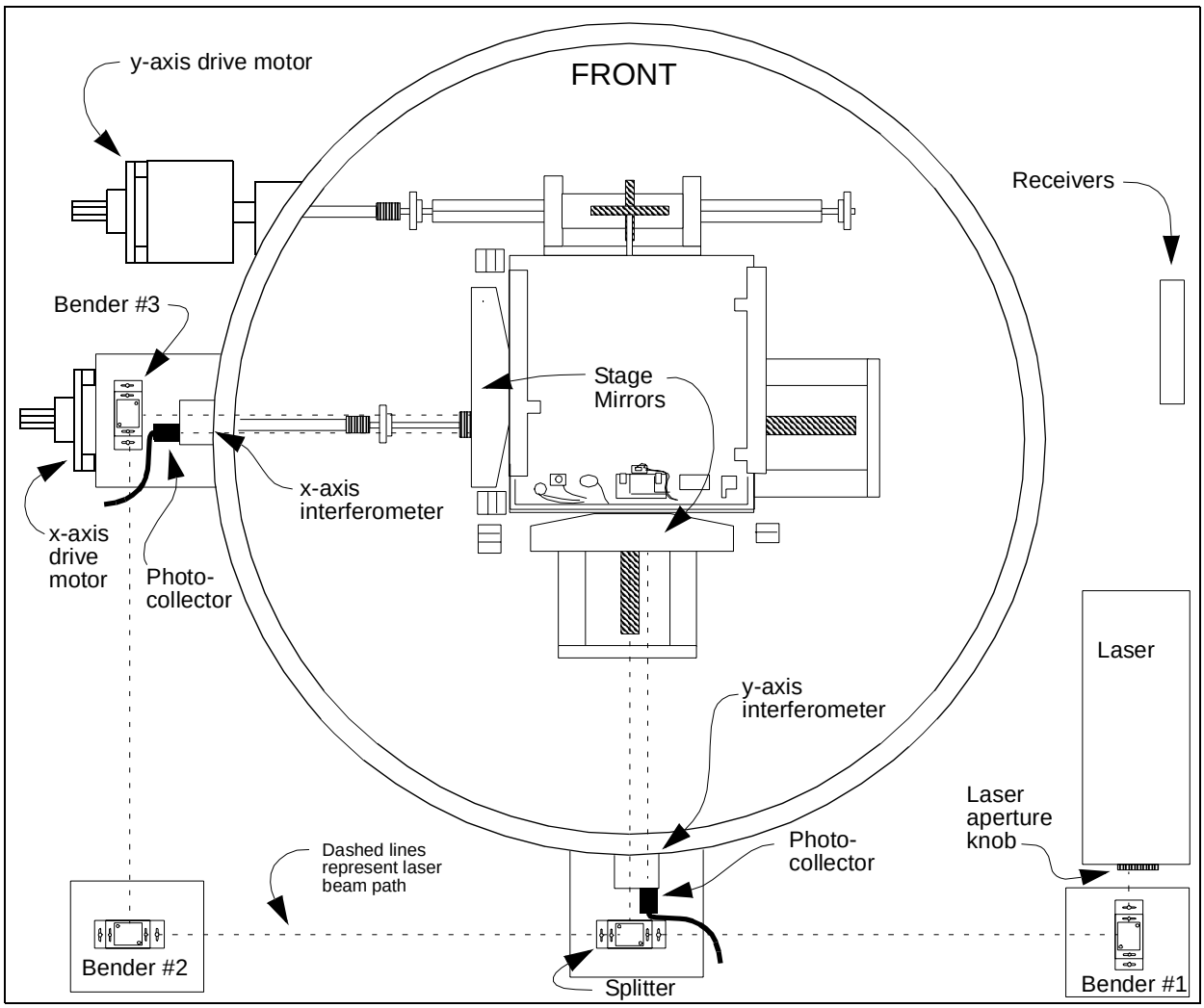


Figure 4. Top View of the Workchamber and Laser IF System (Lid Open)

4-2. Turn on the laser system power.

4-3. Remove the laser tube shrouds and interferometer covers.

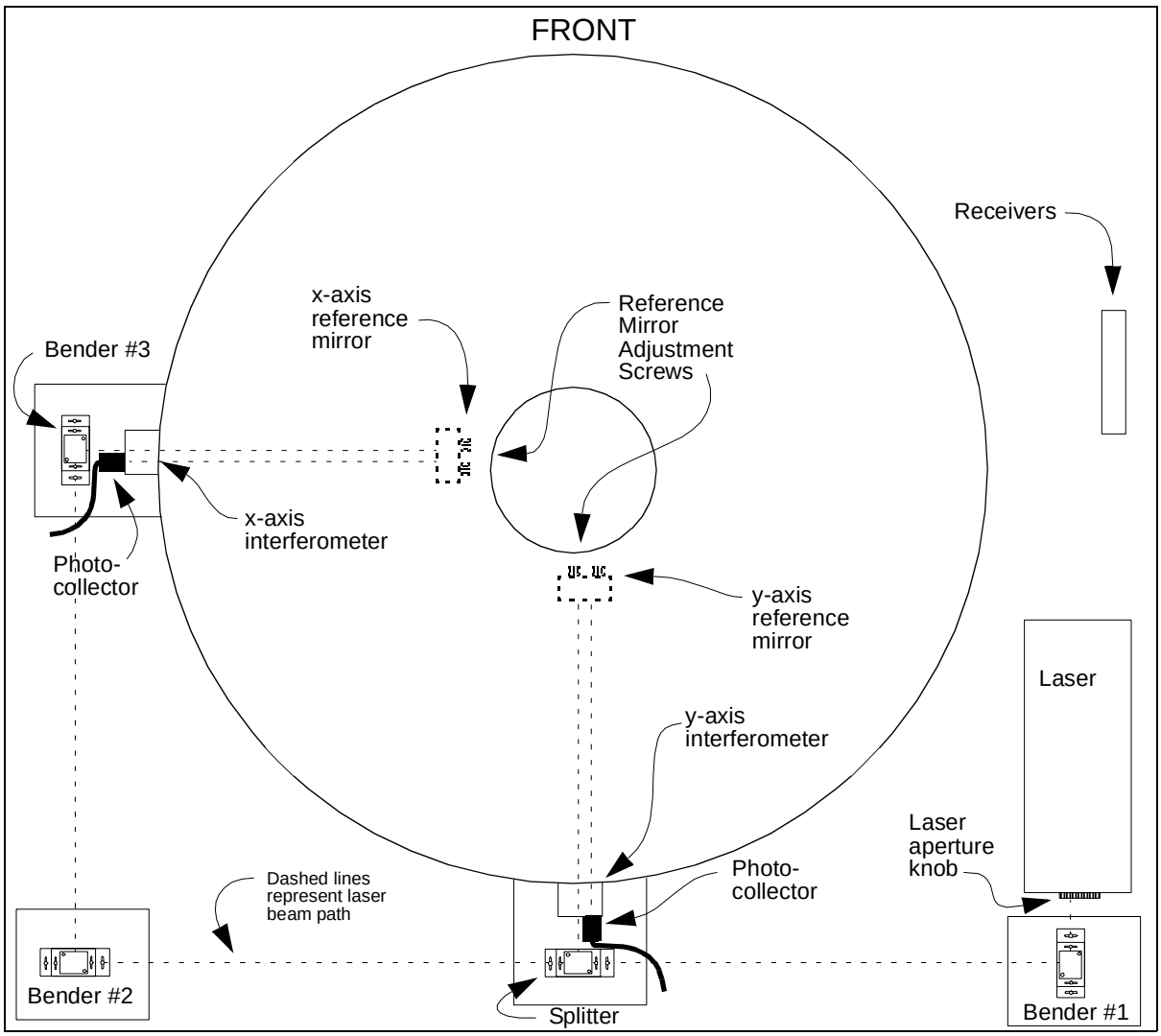


Figure 5. Top View of the Workchamber and Laser IF System (Lid Closed)

4-4. Use a small slotted screwdriver to rotate the potentiometers on the sides of the receivers fully clockwise (to maximize gain).

4-5. Use a multimeter to check the voltage at the pins on the back of the receiver. An output voltage of 1.5 V (minimum) is an indication that the laser system is fairly well aligned, but the system may still require alignment.

4-6. Rotate the aperture knob on the laser to the small aperture position. Hold a piece of plastic or paper in front of the beam. Rotate the aperture knob (slightly) until the spot on the paper or plastic is as bright and as round as possible. *Do not rely on the line(s) on the aperture knob for output alignment; they should only be used as a rough indication of aperture position.*

4-7. Hold an HP laser target over the input to beam bender #1. Loosen the laser mounting bolts

and adjust the laser position until the beam is centered on the laser target (and therefore the input to beam bender #1). If necessary, loosen the two socket head screws on bender #1's mounting plate to adjust the lateral position of bender #1 (so that the beam is centered on the input to bender #1), then tighten them again. Figure 6 provides detail on the location of the beam bender lateral and rotational adjustment screws. Tighten the laser mounting bolts. Check the beam alignment again to make sure that nothing has moved.

4-8. Adjust beam bender #1 (using a laser target) so that the beam output from bender #1 is centered on the input to bender #2 (Figure 4 shows the location of the beam benders). It may be necessary to adjust the rotational and lateral position of bender #1 in order to center the beam on the input to bender #2. If this is the case, check the beam alignment at the input to bender #1, and adjust if necessary.

Note: the goal is to get the beam centered on each bender without changing the alignment of previously aligned benders. Previous alignments are less likely to be affected if you only have to adjust the beam bender's rotational position.

4-9. Adjust beam bender #2 (using a laser target) so that the beam output from bender #2 is centered on the input to bender #3. It may be necessary to adjust the rotational and lateral position of bender #2 in order to center the beam on the input to bender #3. If this is the case, check the beam alignment at the input to bender #2, and adjust if necessary.

4-10. Adjust beam bender #3 so that the output of bender #3 is centered on the reference port of the x-axis interferometer (see Figure 6).

4-11. Use a small Phillips-head screwdriver to loosen the x-axis photo-collector mounting screw. Remove the photo-collector from the measurement port of the x-axis interferometer.

4-12. Place a piece of white paper or Scotch tape over the x-axis interferometer measurement port (see Figure 6). Adjust beam bender #3 so that the beam reflected off the stage mirror is centered on the measurement port and is as bright as possible. If no red glow is visible at the measurement port, it may be necessary to adjust the x-axis reference mirror (see Figure 5).

4-13. Adjust beam bender #3 and the x-axis reference mirror so that the beam is reflected back into the measurement port, them do a more precise adjustment by maximizing the brightness of the red glow at the measurement port. Another technique is to slide a strip of glossy thermal printer paper into the slit in the side of the interferometer so that it covers the reference beam: this will diffuse the beam. Scotch tape must be used at the measurement port to detect the reflected glow (paper will obscure it). Then adjust the position of bender #3 and the x-axis reference mirror to maximize the brightness of the red glow at the measurement port.

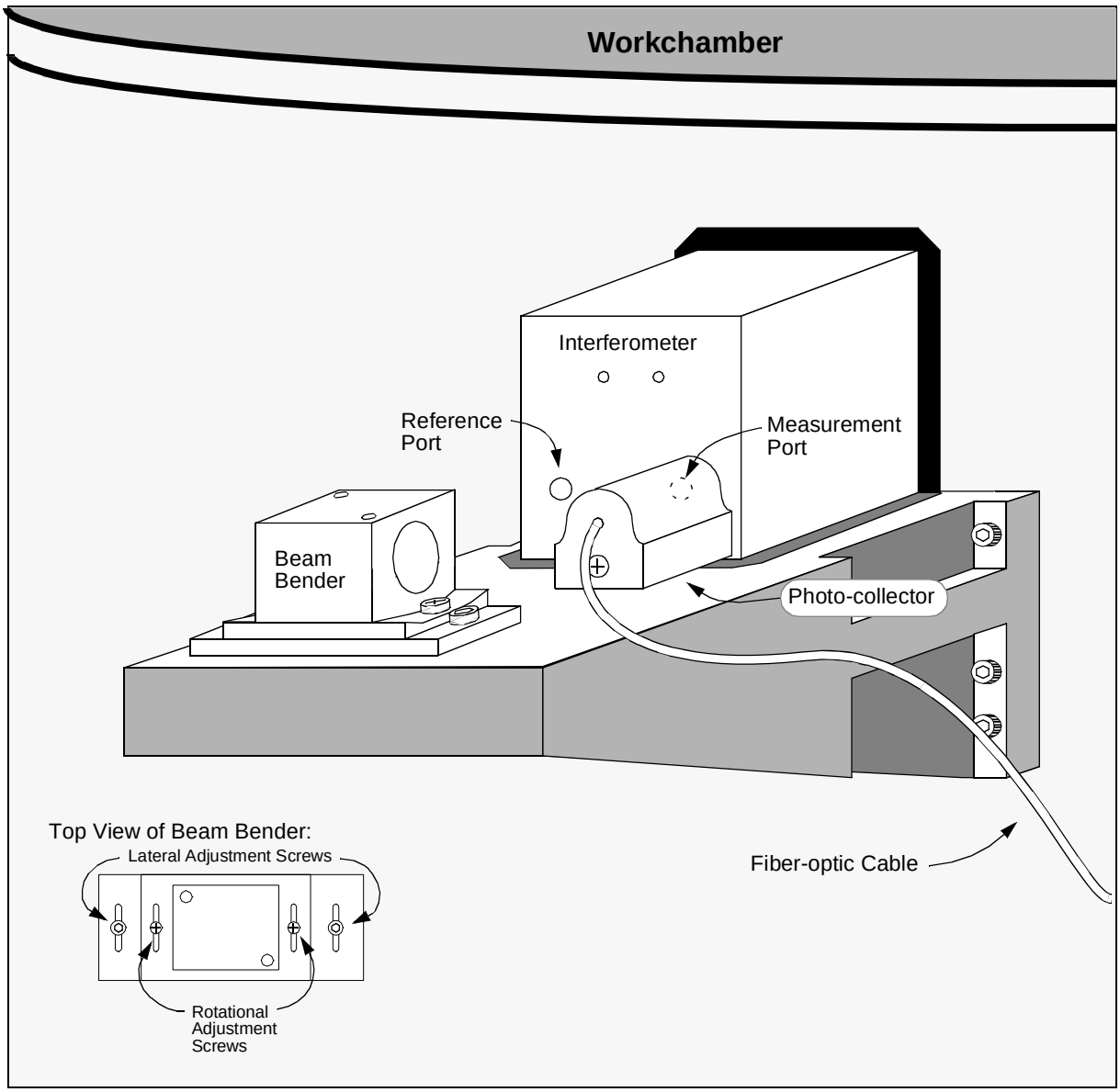


Figure 6. Interferometer, Photo-collector, and Beam Bender

4-14. When the measurement output (glow) has been optimally adjusted, put the photo-collector back in place at the measurement port. Check the green LED on the side of the x-axis receiver; it should be illuminated. If the LED is not on, try to align bender #3 and the x-axis reference mirror again (repeat steps 3-9 through 3-12). If the LED is on, use a multi-meter to check the voltage at the pins on the back of the receiver; the output voltage should be 1.5 V (minimum). If the output voltage is not 1.5 V (minimum), try to align bender #3 and the x-axis reference mirror again.

Note: wires, cables, fingers, etc. can block the beam pathway. If you lose the signal completely, check for beam path obstructions before starting realignment. It is also possible to lose the signal if the interferometer fiber-optic cable is pinched (by a cable tie, etc.)

4-15. When bender #3 is aligned so that the green LED on the side of the x-axis receiver is on and the receiver output voltage is 1.5 V (minimum), check to see that the beam is reflecting back to the laser. Insert an alignment aid tool (HP 10706-60202) into the slit in the side of the x-axis interferometer so that the clear plastic end of the tool covers the (output) of the reference beam. This should produce an "autoreflection" of the beam.

CAUTION

The laser incorporated in the FIB System is a Class 2 (low power) laser. Eye damage can result if you look directly into the beam or into a specular (mirror-like) reflection of it. Do not stare into the beam or into a specular reflection of it.

4-16. Look **indirectly** into the output of the laser. A **very faint** (almost transparent) disk should be visible within the laser output port. If the disk isn't visible, move the (plastic end of the) alignment aid tool so that it alternately covers and uncovers the reference beam output: the disappearance and reappearance of the autoreflection disk can aid in its detection.

4-17. Repeat the alignment procedure for the y-axis.

4-18. After the x-axis and y-axis beams have been aligned, rotate the laser output aperture to the large aperture. Ensure that the beam output is centered within the large aperture (the sides of the aperture opening should not interfere with the beam).

4-19. Connect a multimeter to the pin on the back of the x-axis receiver. Use a small slotted screwdriver to rotate the potentiometer on the side of the receiver counterclockwise until the output voltage is approximately 1.0 V. Repeat for the y-axis receiver.

4-20. Install the laser tube shrouds and interferometer covers.

Micrion

Service Procedure No.: **03-06**
Service Procedure Title: **Stage Height and Carrier Flatness Measurement**
Applicable Systems: **8000, Micrion 9800 FlipChip, MicroMill HT**
Frequency of Service: **Annually and as needed**

Introduction

This procedure sets the registration height for the carrier (sometimes referred to as a holder or a cassette), and checks carrier flatness. The checking and adjusting of the quartz flatness plate requires about 1 hour.

Differences Among the Three Models

The **MicroMill HT** requires three spacers to bring the quartz flatness plate to the same height as the silicon grid; on the **8000** and the **9800**, the quartz flatness plate is already at the same height the silicon grid. The illustrations in this procedure show the three spacers.

Materials Required

This procedure requires the use of the following materials and equipment:

- Clean-room gloves
- Allen wrenches: 3/8", 5/64", and 1/16"
- Quartz flatness plate (180-00540)
- Three 0.391" spacers (MicroMill HT only)
- Height transfer gauge, Starrett 232 or equivalent
- Height transfer gauge adapter stand (180-00430)
- Dial indicator, resolution to 0.0001" (2.5 μm) or better
- 3/8" box wrench to drive X-axis lead screw
- Locktite 222

NOTICE

Per paragraph 11.1 of Safety Guidelines for Semiconductor Manufacturing Equipment (S2-93), this procedure is a Type 3 task. Specifically: “Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are less than 30 volts RMS, 42.2 volts peak, 240 volt-amps, and 20 Joules.”

Configure the Chemical Sources in "Safe" Mode

Before performing the tasks described in this procedure, you must put the chemical sources in a "safe" mode; see Service Procedure 02-01.

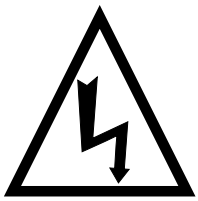
WARNING

Do not proceed until the chemical sources are secure. The chemical reservoirs in FIB systems contain hazardous materials. Labels affixed to the exterior of a chemical cabinet identify the chemical(s) contained inside. If a chemical source is not in its "safest" state, as described in **Service Procedure 02-01**, it is possible for a combination of component failures to release the chemical(s) through a cabinet's delivery line, a roughing line, a purging line, or from a chemical reservoir into the workchamber. Do not open the workchamber, or disassemble any part of the vacuum pumping system, or detach any gas line from any chemical cabinet until you are sure that every chemical source attached to the FIB system is in its "safest" state.

Power Down and Vent the System

Before performing the tasks described in this procedure, you must power down the high voltages and vent the system; see Service Procedure 01-02.

WARNING



Dangerously high voltages are present in the process module while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and automatic procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

Open the Workchamber

Remove the front panels to gain access to the workchamber cover. When the system is completely vented, open the workchamber cover by removing the socket-head cap screws and lifting the cover all the way back.

WEAR GLOVES, DO NOT HANDLE SOLVENTS

When working inside the chamber or when handling any components that will be exposed to vacuum, wear gloves rated for Class 100 environments or better. Due to disintegration of such gloves by solvents, do not handle solvents or parts that are wet with solvent.

Part 1. Install the Quartz Flatness Plate, Spacers, & Height Transfer Gauge

Install the quartz flatness plate, three spacers (MicroMill HT only), and the height transfer gauge:

1-1. Load the quartz flatness plate onto the stage:

a. Inspect the dull-finish side of the quartz flatness plate for worn spots. Avoid using any old spots on the quartz flatness plate where the plungers have worn the surface.

b. Move the stage (manually or via the *Stage* icon in the *Microsurgery* program) to the back of the workchamber.

c. With open end of a 3/8" wrench, push in the lift rod. See Figure 1. While pushing the lift rod in, slide the quartz flatness plate, smooth-finish side *up*, to the rear of the stage.

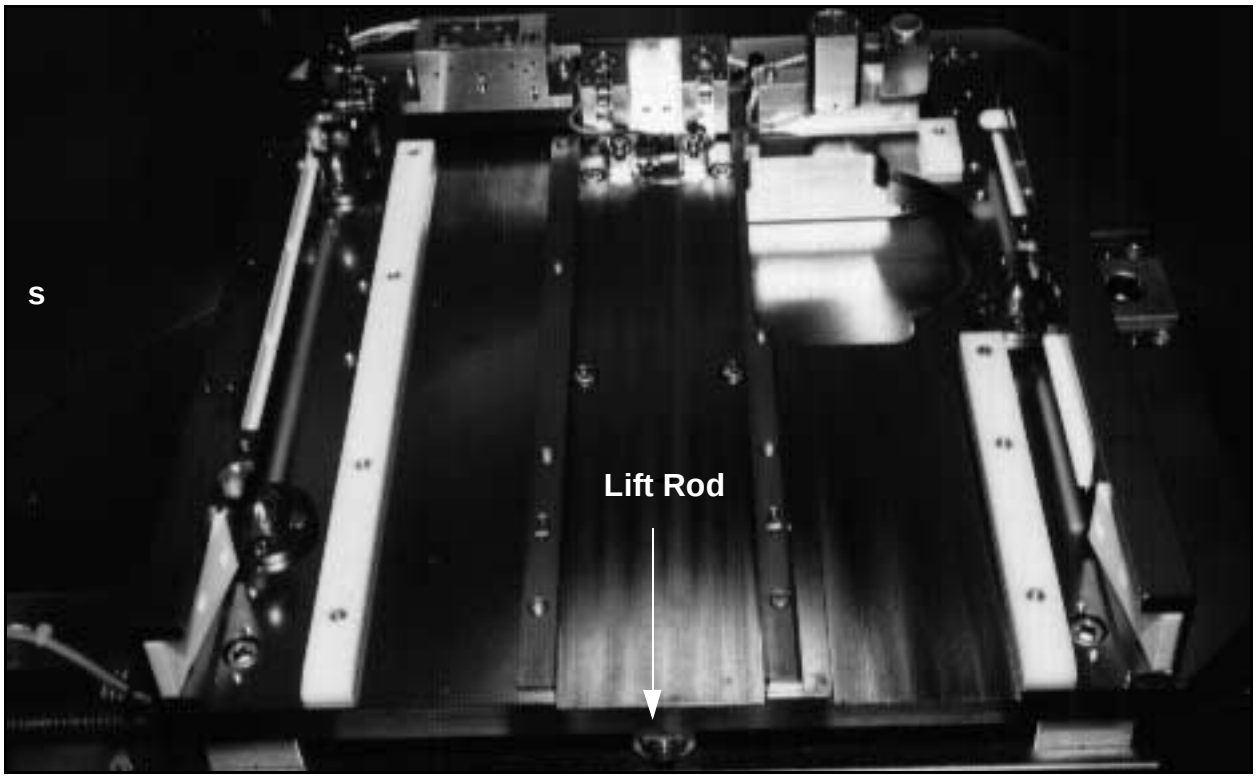


Figure 1. Lift Rod at Stage Front

d. Release the lift rod, allowing the quartz flatness plate to be clamped into position.

1-2. **MicroMill HT only**: Place spacers as close to the set screws as possible. See Figure 2.

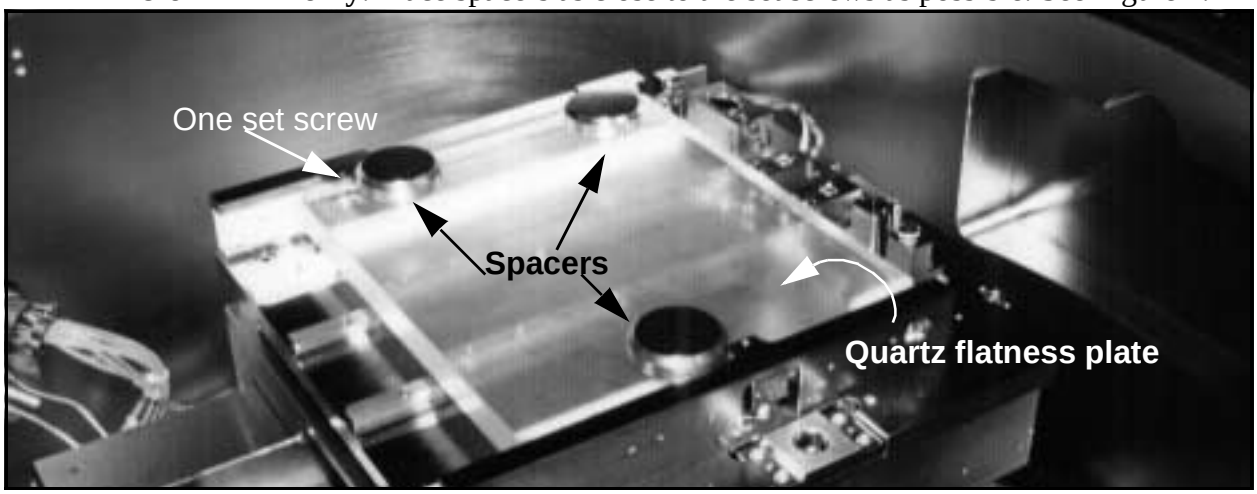


Figure 2. Quartz Plate and Spacers (Spacers used on MicroMill HT only)

1-3. Attach the adapter block to the height transfer gauge.

1-4. With one socket-head cap screw, install the height transfer gauge on the edge of the work-chamber as shown in Figure 3.

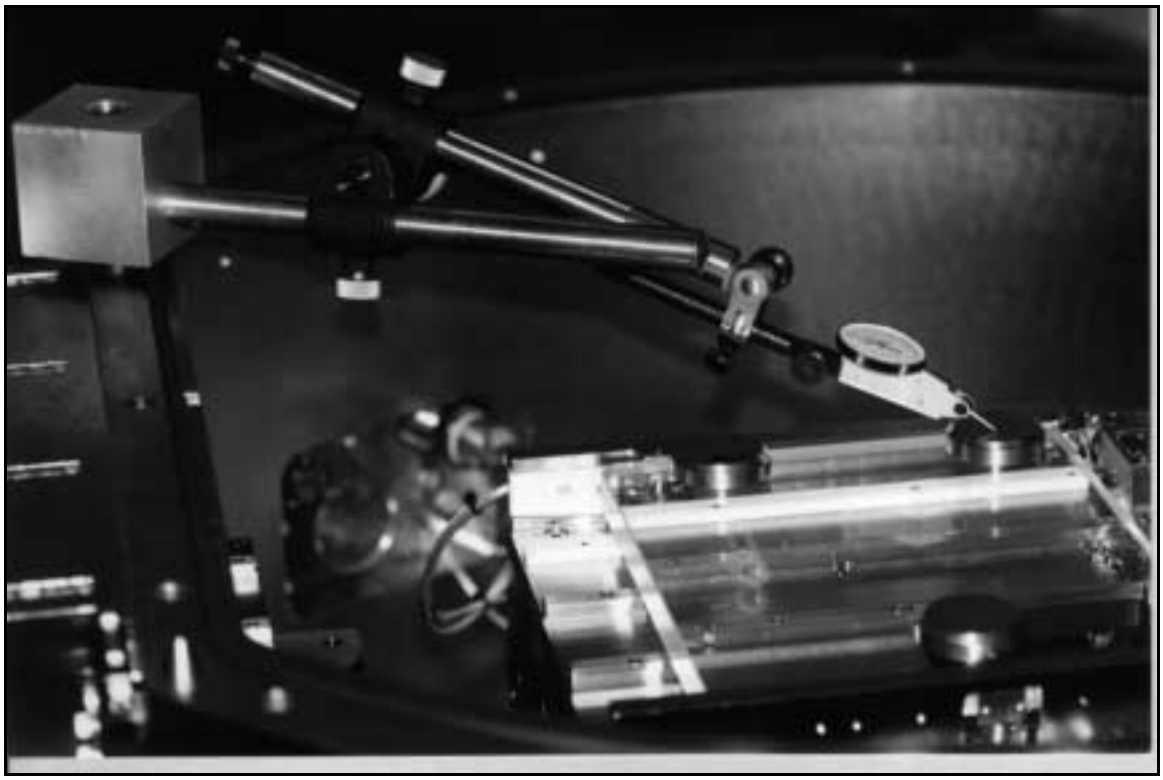


Figure 3. Height Transfer Gauge on the Edge of the Workchamber

Once in place, the height transfer gauging head should not be moved. If you bump or otherwise move the gauging head during the flatness procedure, you must start over from step 2-1.

Manually Rotating the Lead Screws

The X-axis lead screw can be rotated by means of a 3/8" box-end wrench on the motor shaft; the motor is outside the workchamber, to the right of the workchamber as you face it. Clockwise rotation moves the stage in the positive X direction (to the right of the chamber).

To move the stage on the Y axis, manually rotate the lead screw by hand inside the workchamber. Clockwise rotation moves the stage in the negative Y direction (toward the front of the chamber).

NOTICE: Y-Axis Lead Screw is Easily Damaged

To rotate the y-axis lead screw, use the coupling (see Figure 4) in the front of the stage or else rotate the lead screw as close to the stage housing as possible in the rear of the stage**.**

When manually rotating the Y-axis lead screw, try to rotate the coupling on the front of the lead screw (see Figure 4). Any rough movement can warp the lead screw, especially if moved from the rear. If rotating from the rear of the stage, grip the lead screw as close to the stage housing as possible**.**

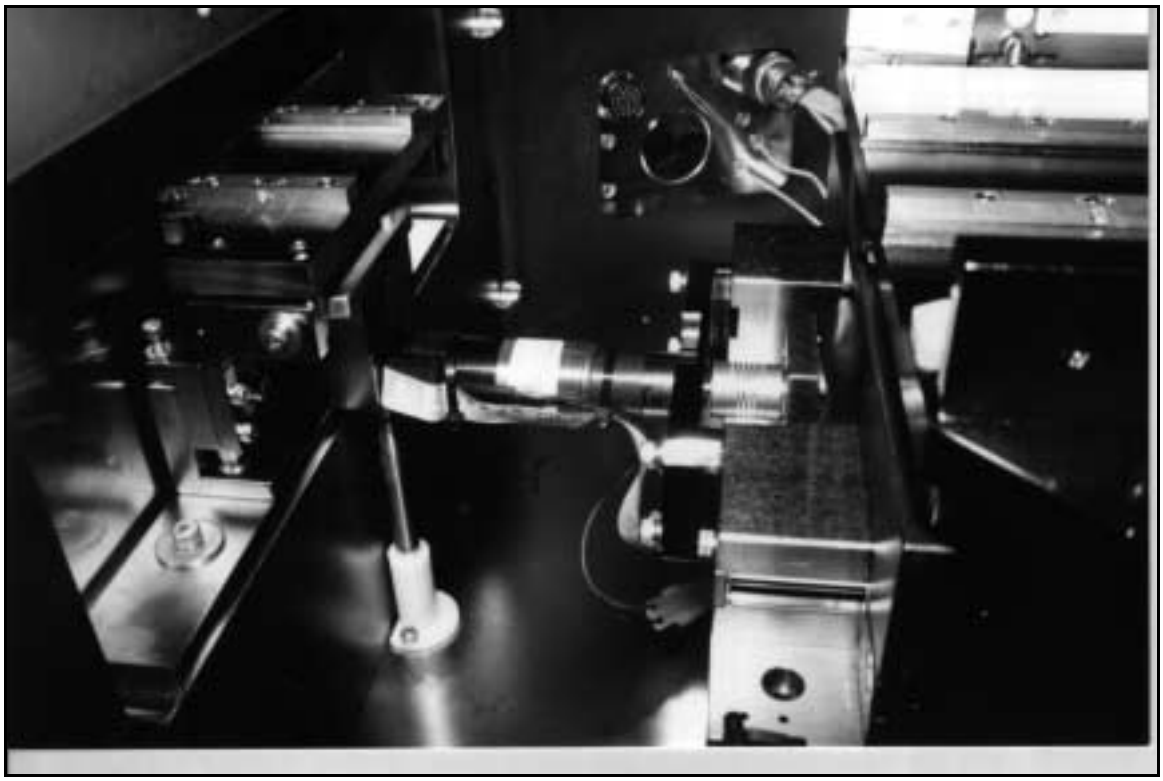


Figure 4. Y-axis Lead Screw (MicroMill HT Shown)

Part 2. Verify Silicon Grid Flatness

With the height transfer gauge in place, check the silicon grid wafer for coplanarity with the silicon grid block; the silicon grid block is used as the reference point for all other measurements in this procedure.

2-1. Move the stage, bringing the edge of the grid block under the gauging head. See Figure 5.

Figure 5. Silicon Grid Wafer and Grid Block

2-2. Turn the indicator dial to set the dial reading to 1 (or to any value, as long as it remains constant throughout the procedure).

2-3. By rotating the y motor shaft, move the gauging head across the grid block and across the wafer. The height of the block and wafer should be the same within 0.0002" total deviation. If it is not, adjust the socket-head screws with a 1/16" Allen wrench.

2-4. Adjacent to the silicon grid is the focusing target. It must be coplanar to (even with; at the same height as) the reference block.

2-5. Move the gauging head back to the silicon grid block. The next part of the procedure is rough alignment. Rough alignment begins with the gauging head at the value determined in step 2-2. The setting that you use for the height of the silicon grid block becomes the constant value (i.e., the reference point) for the five other checkpoints.

Part 3. Check for Stage Flatness and Adjust

In this part, you move the stage checkpoints one at a time under the gauging head. The five checkpoints are shown in Figure 6.

- Silicon grid reference block
- **MicroMill HT**: Each of the three spacers; **8000 and 9800**: quartz flatness plate at three points
- Ion Faraday cup
- Electron Faraday cup

Each of the checkpoints can be raised or lowered.

The first iteration is for rough alignment of all checkpoints; the next three iterations are for increasingly fine adjustment of the quartz flatness plate in relation to the silicon grid; the final iteration checks the height of all checkpoints again.

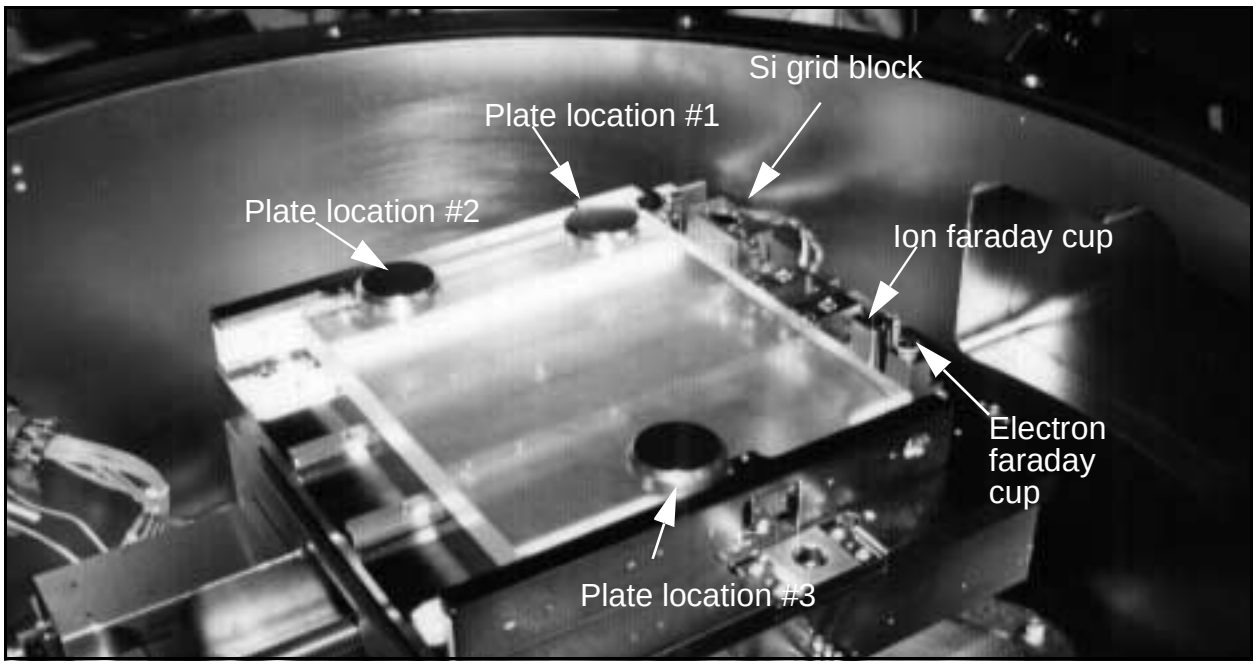


Figure 6. Checkpoints for Stage Flatness (Spacers used on MicroMill HT only)

Rough Adjustment

Using the set screws, adjust each plate location to within 0.0002" of the constant value. It is a rough adjustment because, due to mechanical shifting, the adjustments made at the beginning of the procedure will be affected by the adjustments made at the end of the procedure.

In the following procedure, the **spacers are required for the MicroMill HT only**. For 8000 and 9800 systems, the quartz flatness plate is checked near each of the three set screws.

3-1. Move the stage in -Y to place the gauging head on any point at plate location #1 shown in Figure 6. Adjust the set screw with the 5/64" Allen wrench to be within 0.0002" of the reference point.

3-2. Move the stage in -Y to place the gauging head on any point at plate location #2 shown in Figure 6. Adjust the set screw with the 5/64" Allen wrench to be within 0.0002" of the reference point.

3-3. Move the stage in +Y and +X to place the gauging head on any point at plate location #3 shown in Figure 6. With the 5/64" Allen wrench, adjust the set screw to place the ion faraday cup within 0.0002" of the reference point.

3-4. Move the stage in +Y to place the gauging head on the center of the ion faraday grid shown in Figure 6. With the 1/16" Allen wrench, adjust the two horizontal set screws to bring the ion faraday cup below the reference point.

3-5. Move the stage in -X to place the gauging head on the center of the electron faraday grid shown in Figure 6. On the electron faraday cup, one set screw is a horizontal set screw and one is a vertical set screw on the *bottom* on the electron faraday block. To adjust the electron faraday cup, you must remove it completely from the stage. Do not do this unless the electron faraday cup is not within 0.001"-0.002" below the gauging head.

Fine Adjustment

3-6. Move the stage to place the grid block under the gauging head. Check that the setting on the dial indicator is unchanged from the rough alignment.

3-7. If the setting on the dial indicator has changed, start over from the rough adjustment.

3-8. Move the stage to place the gauging head on the three plate locations, stopping at each location to adjust the respective set screw. The resulting height reading on the dial indicator should be the same as that for the reference point.

3-9. Repeat steps 3-6 through 3-8 twice more.

Final Check

3-10. Move the stage to place the grid block under the gauging head, and check that the dial indicator shows the same value for the reference point as it had during fine adjustment.

3-11. Move the stage to bring plate location #1 under the gauging head, and check that the dial indicator shows the same value as for the reference point, within 0.0001".

3-12. Move the stage to bring plate location #2 under the gauging head, and check that the dial indicator shows the same value as for the reference point, within 0.0001".

3-13. Move the stage to bring plate location #3 under the gauging head, and check that the dial indicator shows the same value as for the reference point, within 0.0001".

3-14. Move the stage to bring the ion faraday cup under the gauging head, and check that it is below the reference point.

3-15. Move the stage to bring the electron faraday cup under the gauging head, and check that it is below the reference point.

3-16. Apply one drop of Locktite 222 to each of the three stage set screws shown in Figure 6.

Part 4. Carrier Flatness

This procedure assumes a height transfer gauge is in place as described in step 1-4. Check any carrier for flatness after the stage has been verified as flat. The reference pads shown in Figure 7 serve as checkpoints. If all three reference pads are within 0.0001" on the dial indicator, the stage is within tolerance for flatness. If not, return the carrier to Micrion Product Support.

Note: in measuring the height of the reference pads, if the second reference pad is within +0.0001" of the first reference pad, then the third reference pad must also be within +0.0001" of the first reference pad. Or, if the second reference pad is within -0.0001" of the first reference pad, then the third reference pad must also be within -0.0001" of the first reference pad.

4-1. Install a carrier onto the stage.

4-2. Move the stage to bring one of the reference pads under the gauging head. Set the dial indicator to 0 or to any chosen value; this will be the value that must be matched by the other two reference pads.

4-3. Move the stage to bring a second reference pad beneath the gauging head (See Figure 7 for the three reference pads). Check the dial indicator. Is it within +/- 0.0001" (1.28 μm) of the first reference pad? If so, proceed to check the third reference pad. If not, return the carrier to Micrion Product Support for recalibration.

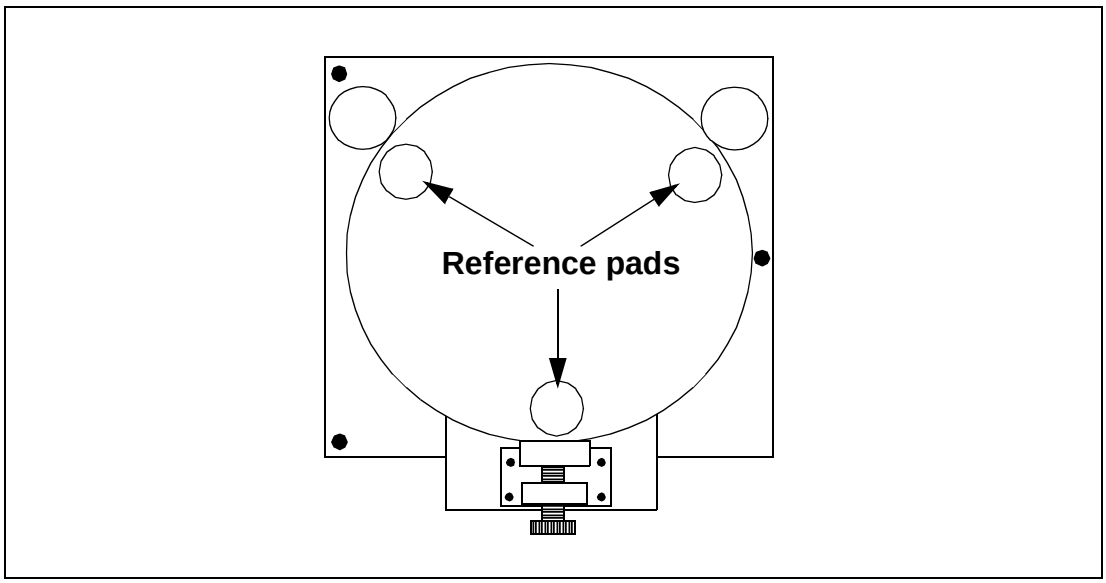


Figure 7. Reference Pads on the MicroMill HT Carrier

4-4. Move the stage to bring the third reference pad beneath the gauging head. Check the dial indicator. Is it within 0.0001" of the reference point? If so, the carrier is flat. If not, return the carrier to Micrion Product Support for recalibration.

Micron

Service Procedure No.: **03-07**
Service Procedure Title: **Clamp Actuator Inspection**
Applicable Systems: **8000, Micron 9800 FlipChip, MicroMill HT**
Frequency of Service: **Semiannually**

Introduction

On the worktable inside the workchamber there are three spring-loaded tapered dowel pins, called plungers. When lowered, the plungers allow a carrier to be positioned on the worktable; when raised again, the plungers clamp the carrier in place.

The chain of events starts with the VacCon telling the fluids regulator to send a 5V "forward" signal to the air cylinder underneath the workchamber. This brings 24V to the air cylinder piston that moves a rack and pinion. Inside the workchamber, beneath the loadlock backing plate, is a cam shaft and cam. When the rack and pinion are activated, the cam shaft turns 270 degrees.

The rotation of the cam shaft causes its cam to push the lift rod, which is on the bottom of the worktable. The inward movement of the rod lowers the plungers.

After the cassette closes the limit switch, the air cylinder receives the 5V "back" signal from the fluids regulator. As a result, the piston pulls back, rotating the cam shaft back to its original position. The actuator springs forward again, lifting the plungers into the the bottom of the carrier and clamping it into position.

The clamped and unclamped state of the clamp actuator are sensed by the position sensors on the piston itself.

Materials Required

This procedure requires the use of the following materials and equipment:

- Clean-room gloves
- *Vacchat* program
- Clean straight-edge ruler

NOTICE

Per paragraph 11.1 of Safety Guidelines for Semiconductor Manufacturing Equipment (S2-93), this procedure is a Type 3 task. Specifically: "Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are less than 30 volts RMS, 42.2 volts peak, 240 volt-amps, and 20 Joules."

Part 1. Checking the Air Cylinder

Using the *vacchat* program, check that the air cylinder is turning the cam shaft gear. This procedure begins with no cassette in the chamber.

Throughout the procedure, check the ion gauge status. If the vacuum decreases during any action, it is likely that you will have to go to Service Procedure 04-09, *Cleaning the Rotary Shaft Vacuum Feedthroughs*. A decrease in vacuum level means an increase of two in the most significant digit; for instance, if the base pressure is 3×10^{-7}, but after a command it falls to 7×10^{-7}, the rotary shaft vacuum feedthrough(s) should be cleaned. See Service Procedure 04-09 for details.

1-1. Check the vacuum level by querying the status of the ion gauge:

`sthc` or `stcc`

1-2. Give the command to unclamp the clamp actuator:

`cau`

1-3. Check the vacuum level by querying the status of the ion gauge:

`sthc` or `stcc`

1-4. Give the command to read the status of the clamp actuator:

`stca`

The message should read: `unclamped, not banked`

1-5. Type the command to extend the transport carriage into the chamber:

`ex`

1-6. Check the vacuum level by querying the status of the ion gauge:

`sthc` or `stcc`

1-7. Give the command to read the status of the clamp actuator:

`stca`

The message should read: `unclamped and banked`

1-8. Give the command to clamp the clamp actuator:

`cac`

1-9. Check the vacuum level by querying the status of the ion gauge:

`sthc` or `stcc`

1-10. Give the command to read the status of the clamp actuator:

`stca`

The message should read: `clamped and banked`

1-11. Type the *vacchat* command that retracts the transport carrier:

`re`

1-12. Check the vacuum level by querying the status of the ion gauge:

```
sthc or stcc
```

1-13. To remove the transport carrier and check the status of the clamping actuator, type:

```
ex
cau
re
cac
```

Part 2. Securing the Chemicals, Venting, and Opening the Chamber

Configuring the Chemical Sources in "Safe" Mode

Before performing the tasks described in this procedure, you must put the chemical sources in a "safe" mode; see Service Procedure 02-01.

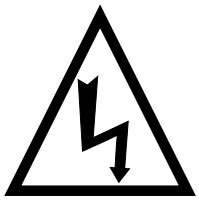
WARNING

Do not proceed until the chemical sources are secure. The chemical reservoirs in FIB systems contain hazardous materials. Labels affixed to the exterior of a chemical cabinet identify the chemical(s) contained inside. If a chemical source is not in its "safest" state, as described in **Service Procedure 02-01**, it is possible for a combination of component failures to release the chemical(s) through a cabinet's delivery line, a roughing line, a purging line, or from a chemical reservoir into the workchamber. Do not open the workchamber, or disassemble any part of the vacuum pumping system, or detach any gas line from any chemical cabinet until you are sure that every chemical source attached to the FIB system is in its "safest" state.

Powering Down and Venting the System

Before performing the tasks described in Part 3 of this procedure, you must power down and vent the system; see Service Procedure 01-02.

WARNING



Dangerously high voltages are present in the process module while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and automatic procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

Opening the Workchamber

Remove the front panels to gain access to the workchamber cover. When the system is completely vented, remove the socket-head cap screws and lift the cover.

WEAR GLOVES, DO NOT HANDLE SOLVENTS

When working inside the chamber or when handling any components that will be exposed to vacuum, wear gloves rated for Class 100 environments or better. Due to disintegration of such gloves by solvents, do not handle solvents or parts that are wet with solvent.

Part 3. Checking the Height of the Plungers

Long scratches on the bottom of the transport carrier indicate that the plungers are too high. In this procedure, you check that the plungers, shown in Figure 1, are below the level of the white rails. The cam position is a function of the stage position

3-1. In the *Stage* popup, send the stage to the *Stage Load* position.

3-2. To lower the plungers, give the command to unclamp the actuator:

```
cau
```

You should see the lift rod moving and the plungers moving down.

3-3. Use a clean straight-edge ruler to determine if the plungers are below the level of the white rails.

If the plungers are too high, follow steps 3-4 through 3-7.

3-4. Give the `cac` command to clamp the actuator.

3-5. In the motorshell *ystage* program, move the stage forward with the `move` command.

3-6. In the *Stage* popup, change the label for *Stage Load* to the current position.

3-7. Unclamp the actuator and check the height again as in steps 3-2 and 3-3.

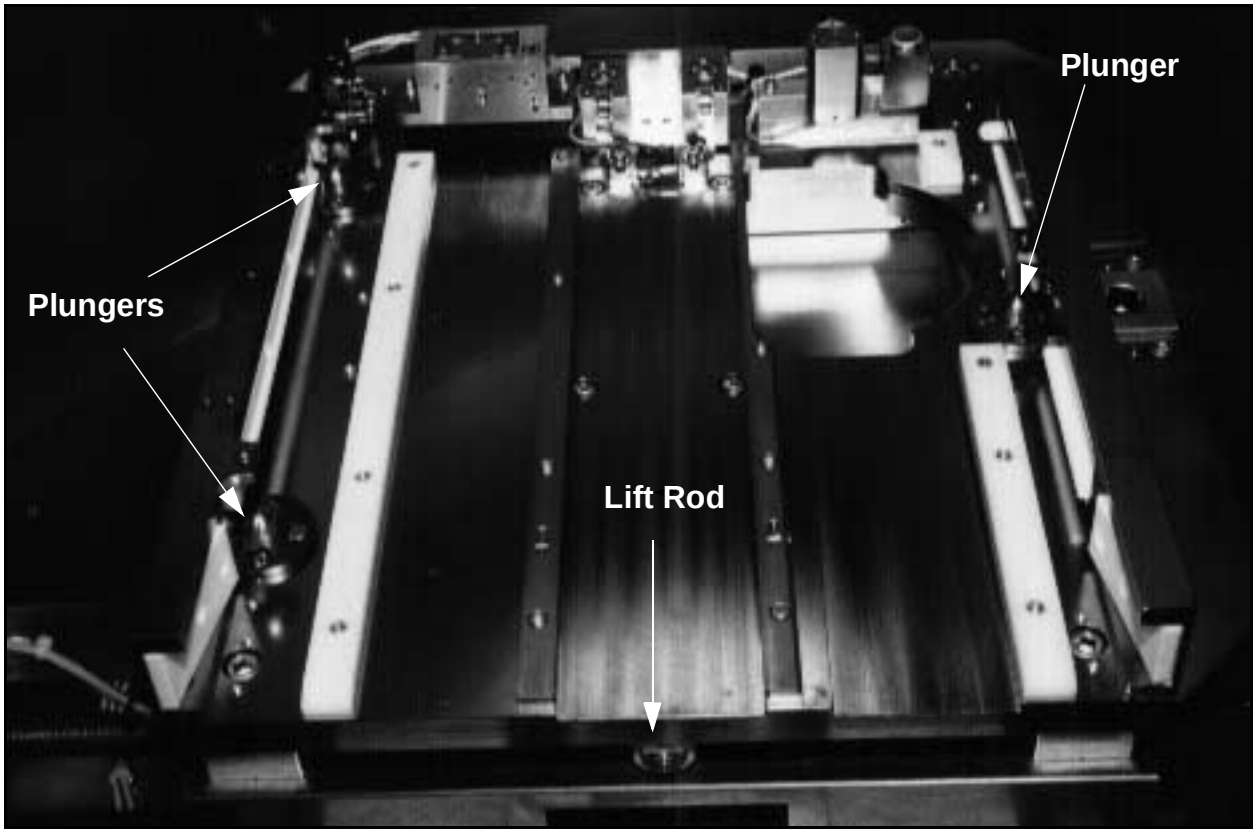


Figure 1. Stage showing Lift Rod and Plungers

Section 4: Vacuum System

- 04-01 Vacuum System Checks
- 04-02 Process Module Vacuum Leak Checks
- 04-03 Pump Down: Automatic and Manual
- 04-04 Roughing/Fore Pump Oil Change
- 04-05 Turbo Pump Replacement
- 04-06 Foreline Trap: Element Replacement
- 04-07 Thermocouple Calibration

Micrion

Service Procedure No.: **04-01**
Service Procedure Title: **Vacuum System Checks**
Applicable Systems: **8000, Micrion 9800 FlipChip, MicroMill HT**
Frequency of Service: **Daily**

Introduction

During normal operation (no unusual outgassing from the sample), the workchamber turbo pump and the column ion pump should maintain a gas pressure between 1.5×10^{-7} torr and 6.0×10^{-7} torr in their respective chambers. This is referred to as the base pressure. This procedure describes how to obtain base pressure readings and suggests what to do if they are too high. These readings should be recorded daily in the system log.

Material and Tools Required

NOTE: All automated programs no longer work in vacserver. This includes autovent, autopump-down, and calabrate functions. This is a temporary situation and will be changed back in the next release of software.

- *vacserver* program
- Circuit tester

Part 1. Checking Workchamber Pressure

NOTE: All automated programs no longer work in vacserver. This includes autovent, autopump-down, and calabrate functions. This is a temporary situation and will be changed back in the next release of software.

Wait at least 10-30 minutes after loading or unloading a sample, or after finishing a deposition, for the vacuum to stabilize before you read the base pressure. Use the *vacserver* program for this procedure.

1-1. If *vacserver* is not currently running, bring any unused xterm window to the front, or display a new xterm window, and enter the following command:

```
vacserver↵
```

1-2. Take a hot or cold cathode ionization gauge reading of the workchamber pressure in *vacserver* by entering one of the following two commands:

`sthc↵` or `stcc↵`

The workchamber pressure should be between 1.5 and 6×10^{-7} torr. Record the reading in the system's logbook.

1-3. Take an ion pump reading of the column pressure by entering the command:

```
spip↵
```

The ion pump pressure should be approximately 6 x 10^{-7} torr. Record the result in the system's logbook.

Part 2. Degassing the HCIG

Note: this is not applicable to systems with CCIGs.

NOTE: All automated programs no longer work in vacserver. This includes autovent, autopumpdown, and calabrate functions. This is a temporary situation and will be changed back in the next release of software.

One cause of high workchamber pressure readings is a contaminated HCIG tube. The "degassing" function in *vacserver* removes contamination from the HCIG. Use this function as follows:

NOTE: All automated programs no longer work in vacserver. This includes autovent, autopumpdown, and calabrate functions. This is a temporary situation and will be changed back in the next release of software.

2-1. Degass the HCIG by entering the following *vacserver* command:

```
hcdg↵
```

2-2. Wait 5 minutes, and then stop the degassing by typing:

```
hcnd↵
```

2-3. Take another HCIG reading as described in step 1-2.

If the pressure readings show improvement to acceptable levels, then a dirty HCIG probably caused the high readings. If there is no improvement in the pressure readings, there could be several causes of a higher pressure reading, such as a contaminated workchamber. If you have ruled out a contaminated HCIG, excessive sample outgassing, and a dirty workchamber as the source of the high pressure readings, refer to Service procedure 04-02, Leak-checking the Vacuum System.

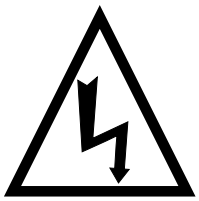
Part 3. Checking Roughing/Fore Pump Power: Single "Wet" Pump Systems

Note: this test is to be performed at installation or as needed; it need not be done on a regular basis.

Power Down the System

Before performing the tasks described in this procedure, you must power down the system; see Service Procedure 01-02.

WARNING



Dangerously high voltages are present in the process module while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and automatic procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

NOTICE

Per paragraph 11.1 of *Safety Guidelines for Semiconductor Manufacturing Equipment* (S2-93), this procedure is a Type 5 task. Specifically: "Equipment is energized. Measurements and adjustments require physical entry into the equipment."

NOTE: All automated programs no longer work in vacserver. This includes autovent, autopumpdown, and calabrate functions. This is a temporary situation and will be changed back in the next release of software.

3-1. In an xterm window, start the *vacserver* program by typing:

```
vacserver
```

3-2. Turn off the turbo pump with the command:

```
hpn
```

3-3. Turn off the roughing/fore pump by typing:

```
fpn
```

3-4. Unplug the roughing/fore pump from its outlet in the power strip in the electronics module. Plug the circuit tester into the outlet (the circuit tester is yellow, slightly larger than a standard AC plug, and has indicator lights on the end opposite its AC plug).

3-5. Turn on the roughing/fore pump with the *vacserver* command:

```
fpy
```

The two yellow lights on the circuit tester should turn on.

3-6. Turn off the roughing/fore pump with the *vacserver* command:

```
fpn
```

The two yellow lights on the circuit tester should turn off.

3-7. Unplug the circuit tester from the roughing/fore pump outlet in the electronics module power strip, and plug the roughing/fore pump back into the power strip.

3-8. Power up the system as described in Service Procedure 01-01.

3-9. Pump down the system as described in Service Procedure 04-03.

Part 4. Checking Roughing/Fore Pump Power: Dual "Wet" Pump Systems

NOTE: this test is to be performed at installation or as needed; it need not be done on a regular basis.

NOTE: All automated programs no longer work in vacserver. This includes autovent, autopump-down, and calabrate functions. This is a temporary situation and will be changed back in the next release of software.

Power Down the System

Before performing the tasks described in this procedure, you must power down the system; see Service Procedure 01-02.

4-1. In an xterm window, start the *vacserver* program by typing:

```
vacserver
```

4-2. Turn off the turbo pump with the command:

```
hpn
```

4-3. Turn off the roughing and fore pumps with the commands:

```
rpn
fpn
```

4-4. Unplug the roughing pump from its outlet in the power strip in the electronics module. Plug the circuit tester into the outlet (the circuit tester is yellow, slightly larger than a standard AC plug, and has indicator lights on the end opposite its AC plug).

4-5. Turn on the roughing pump with the *vacserver* command:

```
rpy
```

The two yellow lights on the circuit tester should turn on.

4-6. Turn off the roughing pump with the *vacserver* command:

```
rpn
```

The two yellow lights on the circuit tester should turn off.

4-7. Unplug the circuit tester from the roughing pump outlet in the electronics module power strip, and plug the roughing pump back into the power strip.

4-8. Unplug the fore pump from its outlet in the power strip in the electronics module. Plug the circuit tester into the outlet (the circuit tester is yellow, slightly larger than a standard AC plug, and has indicator lights on the end opposite its AC plug).

4-9. Turn on the fore pump with the *vacserver* command:

```
fpy
```

The two yellow lights on the circuit tester should turn on.

4-10. Turn off the fore pump with the *vacserver* command:

```
fpn
```

The two yellow lights on the circuit tester should turn off.

4-11. Unplug the circuit tester from the fore pump outlet in the electronics module power strip, and plug the fore pump back into the power strip.

4-12. Power up the system as described in Service Procedure 01-01.

4-13. Pump down the system as described in Service Procedure 04-03.

Micrion

Service Procedure No.: **04-02**
Service Procedure Title: **Process Module Vacuum Leak Check**
Applicable Systems: **8000, Micrion 9800 FlipChip, MicroMill HT**
Frequency of Service: **As needed**

Introduction

This procedure describes checking the process module for a vacuum leak.

This procedure does not provide specific operating procedures for using a helium (He) leak detector. It assumes that you are able to use the leak detector (and its documentation) available at the facility, or that site personnel can provide you with that service.

Materials Required

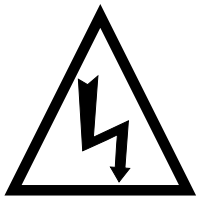
The following materials are required to perform the vacuum leak check:

- Varian 959-50 or 938-41 leak detector or equivalent
- Pressurized He source with length of hose equipped with a directional nozzle
- Standard field service engineer's tool kit

NOTICE

Per paragraph 11.1 of *Safety Guidelines for Semiconductor Manufacturing Equipment* (S2-93), this procedure is a Type 3 task. Specifically: "Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are less than 30 volts RMS, 42.2 volts peak, 240 volt-amps, and 20 Joules."

WARNING



Dangerously high voltage is present in the process module while the FIB system is powered up. All high voltage wiring is heavily insulated and connections are interlocked. However, any such safeguards can fail. Therefore, do not touch any of the wiring in the process module while the FIB system is powered-up.

Part 1. System Preparation

1-1. Make sure that the fore and turbo pumps are running and the entire system (including the loadlock) is under vacuum.

1-2. From the Process Watcher, start the *vacchat* program.

1-3. Check the operation and service records for clues as to the cause of the vacuum problem. For example, if the process module workchamber was recently serviced it would be reasonable to suspect that the workchamber door gasket may be damaged or incorrectly seated.

The loadlock door is sometimes a source of vacuum leaks. Before using the leak detector, check the loadlock as follows:

a. Using *vacchat,* close V6 and V2 to isolate the loadlock. See Figures 1 and 2.

b. Read the vacuum level.

c. Open V6 and read the vacuum level again (contaminants such as grease in the loadlock will eventually finish outgassing like a “virtual leak”).

d. If the reading with V6 closed is higher than when V6 is open, the loadlock door would be a likely source of the leak.

1-4. Locate the turbo pump leak check port on the turbo pump foreline.

1-5. Connect the leak check port on the turbo pump foreline[1] to the leak detector test port. *Do not open the manual valve for the leak check port at this time*.

1-6. Open all of the valves except V1, V5, and CA.

1-7. Turn off the ion pump (using *vacchat*) to maximize the chances of detecting a leak in the area of the column.

1-8. After you set up the leak detector, open the manual valve for the leak check port. See the instructions inside the door to the leak detector.

Part 2. Leak Checking from the Top Down

Since He is lighter than air, always begin leak testing a system from the top down. If you do not, a vacuum leak above the area you are testing may activate the leak detector.

2-1. Begin with the leak detector at moderate sensitivity. If no leaks are discovered, recheck the system with the leak detector at the most sensitive scale. At a sensitivity of 1×10^{-9} cc/sec., the He detector can detect vacuum leaks caused by a fiber caught between an o-ring gasket and mating surface.

2-2. Starting at top of the column, slowly expose the entire system to the He flow. Expose potential leak areas such as flanges, surfaces with gaskets, and electrical and mechanical connectors.

---

[1] Another leak check port is located near TC1 on the roughing line; this port allows you to isolate (by closing V6 and V2) and leak test the loadlock (and roughing line) separately. Most leak testing is done via the port at the turbo pump foreline.

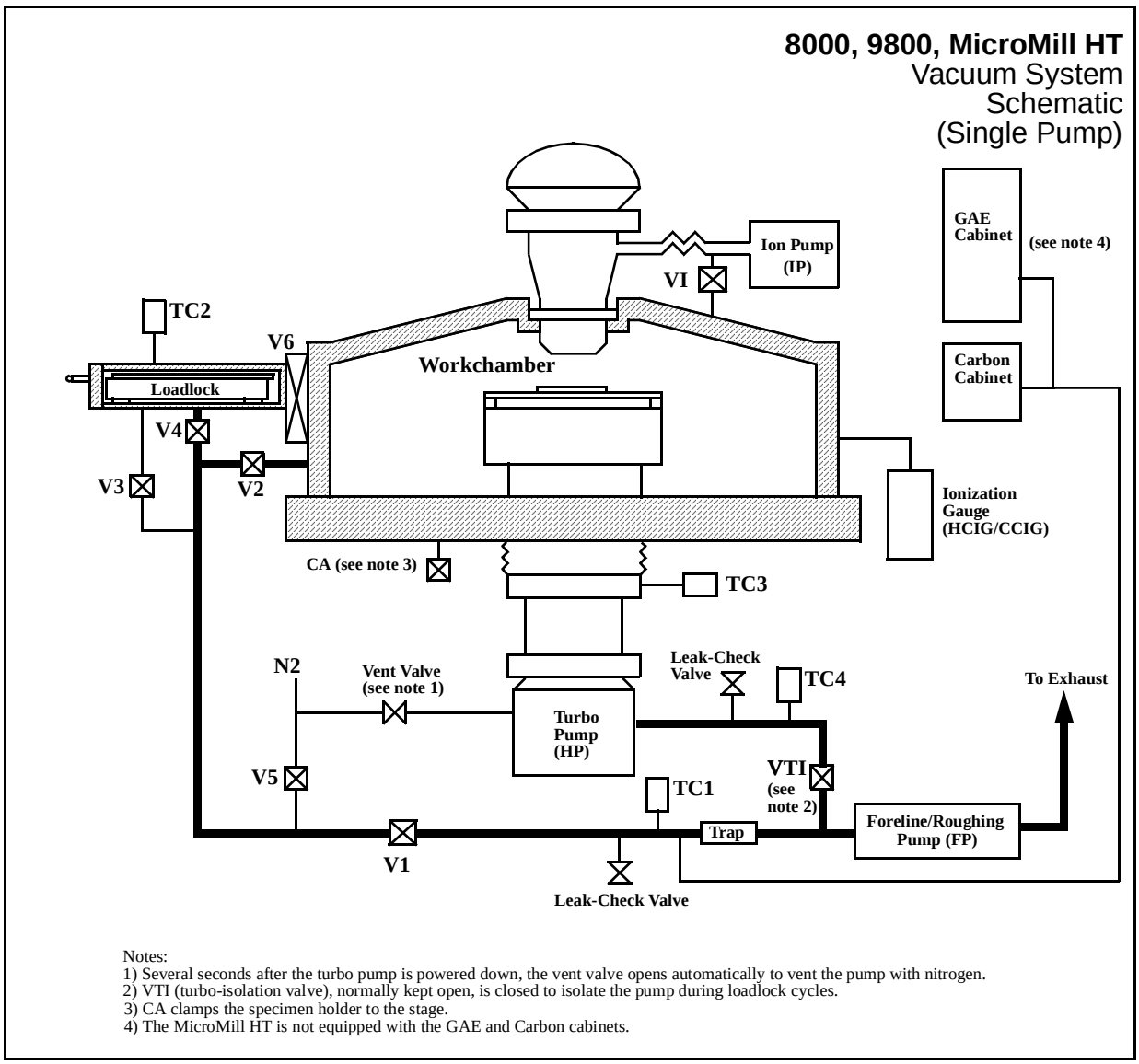


Figure 1. Single Pump Vacuum System

2-3. Be sure to check all vacuum lines and plumbing in a top to bottom sequence.

2-4. When the leak detector emits a whining sound to indicate a leak, proceed as follows:

- Take note of the area you are testing.
- Remove the He nozzle from area and allow the leak detector to return to normal.
- Reduce the flow of the He slightly (to better pinpoint the leak).
- Recheck the area in greater detail and further pinpoint the area of the leak.
- You may have to repeat this process several times before identifying the exact area of the leak.

2-5. To end a leak test, shut the valve and bring down the leak detector. Allow it to spin for 30 seconds before switching it off.

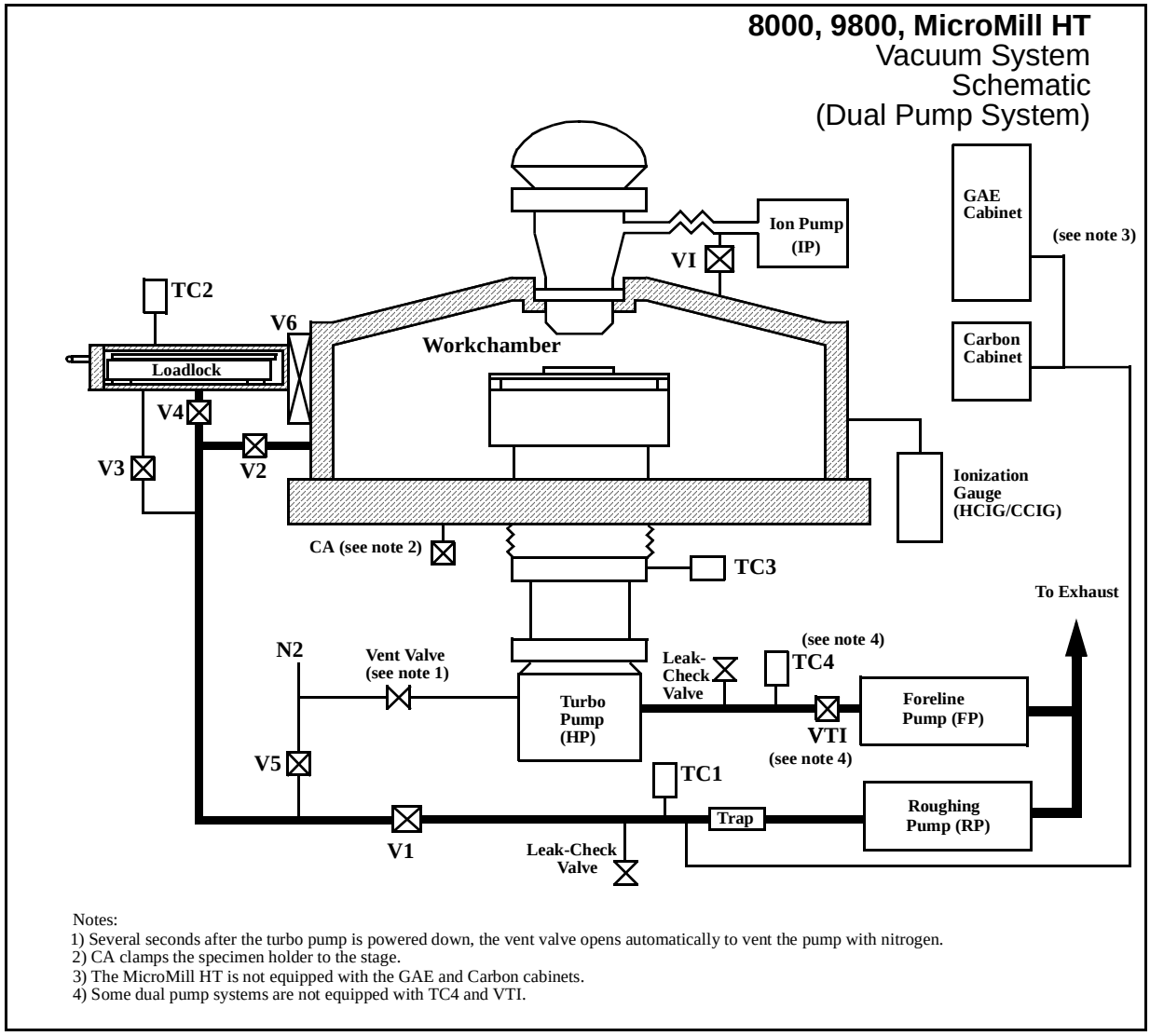


Figure 2. Dual Pump Vacuum System

Micron

Service Procedure No.: 04-03
Service Procedure Title: Pump Down: Automatic and Manual
Applicable Systems: 8000, Micrion 9800 FlipChip, MicroMill HT
Frequency of Service: As Needed

Introduction

Pump down is the process of creating a vacuum of between 1.0×10^{-6} torr and 9.0×10^{-7} torr in the workchamber. Several hours after pump down, the workchamber vacuum is typically between 9.0×10^{-7} torr and 3.0×10^{-7} torr.

Automatic Pumpdown is the procedure to use if you want to include nitrogen purging of the workchamber and loadlock.

Manual Pumpdown is the procedure to use if you do not need to purge with nitrogen.

As often as possible, use a vacuum cleaner to clean the chamber before pumping down.

Tools and Materials Required

- *vacchat* software

Part 1. Automatic Pumpdown

1-1. Shut the workchamber lid and tighten the "T" screw on the front of the lid (so that the switch block on the lid actuates the switch on the top right of the workchamber).

1-2. Make sure that the turbo pump controller is on and correctly configured. If the controller has not been configured, perform the configuration procedure described in section 4 of Service Procedure 04-05, Turbo Pump Replacement.

1-3. Make sure that the loadlock door is shut.

1-4. In an xterm window, start the *vacchat* program by typing:

```
vacchat
```

1-5. To pump down the system automatically, type the *autopump* command:

```
ap
```

1-6. Allow the vacuum to draw the door tight, then install and tighten the workchamber lid bolts.

Part 2. Manual Pump Down: Single (fore/rough) Pump Systems

2-1. Shut the workchamber lid and tighten the "T" screw on the front of the lid (so that the switch block on the lid actuates the switch on the top right of the workchamber).

2-2. Make sure that the turbo pump controller is on and correctly configured. If the controller has not been configured, perform the configuration procedure described in section 4 of Service Procedure 04-05, Turbo Pump Replacement.

2-3. In an xterm window, start the *vacchat* program by typing:

```
vacchat
```

2-4. At the *vacchat* prompt, check the status of the valves by typing:

```
sv
```

The system will display the status of the valves:

```
V1C V2C V3C V4C V5C V6C VIO VTIO VTPC
```

The valves should be in the states shown above; V1 through V6 and VTP should be closed, and VI and VTI should be open (see Figure 1 for valve locations).

If any of the valves V1 through V6 or VTP is open, close each valve by typing the *vacchat* close command. For example, V1 is closed with the following command:

```
clv1
```

If VI or VTI is closed, open each valve by typing:

`opvi` or `opvti`

2-5. Start the fore pump by typing:

```
fpy
```

2-6. Start the turbo pump by typing:

```
hpy
```

2-7. Wait until the turbo pump reaches its operating speed (42 krpm) before proceeding; this will take approximately 5 minutes. Check the status of the turbo pump by typing:

```
sphp
```

The system will display the status of the turbo pump. If the turbo pump has not reached its operating speed, the system will report:

```
Turbo pump is not ready
```

When the turbo pump has reached its operating speed, the system will report:

```
Turbo pump is ready
```

2-8. When the turbo pump is ready, bring up the hot cathode ionization gauge (HCIG) power by typing[1]:

```
hcpu
```

2-9. After minimal exposure to atmosphere, such as a source change, it should take an hour for the pressure in the workchamber to get below 5.00×10^{-6} torr. If the workchamber has been exposed to atmosphere for a prolonged period, it will probably take several hours for the pressure to get below 5.00×10^{-6} torr. To check the workchamber pressure, type:

```
sthc
```

2-10. When the workchamber pressure has reached 5.00×10^{-6} torr, start the ion pump with the following command:

```
ipy
```

The ion pump housing should be cool to the touch. If the housing is hot, turn off the ion pump and check for problems in the vacuum system.

2-11. To check the ion pump pressure, type:

```
spip
```

The ion pump pressure sensor will not read pressures above 5.00×10^{-6} torr; it will display a reading of 5.00×10^{-6} torr until the ion pump pressure is below 5.00×10^{-6} torr.

2-12. When the workchamber pressure has reached 3.00×10^{-6} torr, close VI with the following command:

```
clvi
```

The system will not enable high voltage until the ion pump pressure is below 3.75×10^{-6} torr. The amount of time it takes to pump down (to pressures of 3.75×10^{-6} torr and below) is dependent upon the cleanliness of the column.

---

[1] Some FIB systems have CCIGs rather than HCIGs; the commands `ccpu` or `hcpu` will work on either type.

2-13. Tighten the workchamber lid bolts.

Note: this concludes the manual pump down of the workchamber. The remainder of this section describes the manual pump down of the loadlock, and assumes that the workchamber has been pumped down, the fore and turbo pumps are running, and that the high voltage is enabled.

2-14. Close the loadlock door.

2-15. To begin manual pump down of the loadlock, close VTP with the following *vacchat* command:

```
clvtp
```

2-16. Type the following *vacchat* command to close VTI:

```
clvti
```

Be sure that VTI is closed before proceeding with the loadlock pumpdown. If VTI is not closed before loadlock pumpdown begins, the vacuum in the turbo pump line will suck contaminants from the roughing (and possibly the exhaust) line into the turbo pump and the workchamber.

2-17. Open V1 with the following *vacchat* command:

```
opv1
```

2-18. Open V3 by typing:

```
opv3
```

Opening V3 begins the evacuation of the loadlock through a small diameter vacuum line, and at a relatively low flow rate; this reduces the amount of particulate contamination generated by the evacuation of the loadlock.

2-19. Open V4 by typing the following *vacchat* command:

```
opv4
```

Opening V4 continues the evacuation of the loadlock through a large diameter vacuum line.

2-20. Close V3 with the following *vacchat* command:

```
clv3
```

2-21. Check the status of TC2 by typing:

```
stt2
```

Wait until TC2 < 0.250 torr.

2-22. Open VTI with the command:

```
opvti
```

Note: when TC2 < 0.250 torr, it is safe to open VTI. It is recommended that VTI remain closed for as short a time as possible.

2-23. Check the status of TC2 by typing:

```
stt2
```

Wait until TC2 < 0.065 torr.

2-24. Close V1 by typing:

```
clv1
```

2-25. Open VTP with the command:

```
opvtp
```

2-26. Open V2 with the command:

```
opv2
```

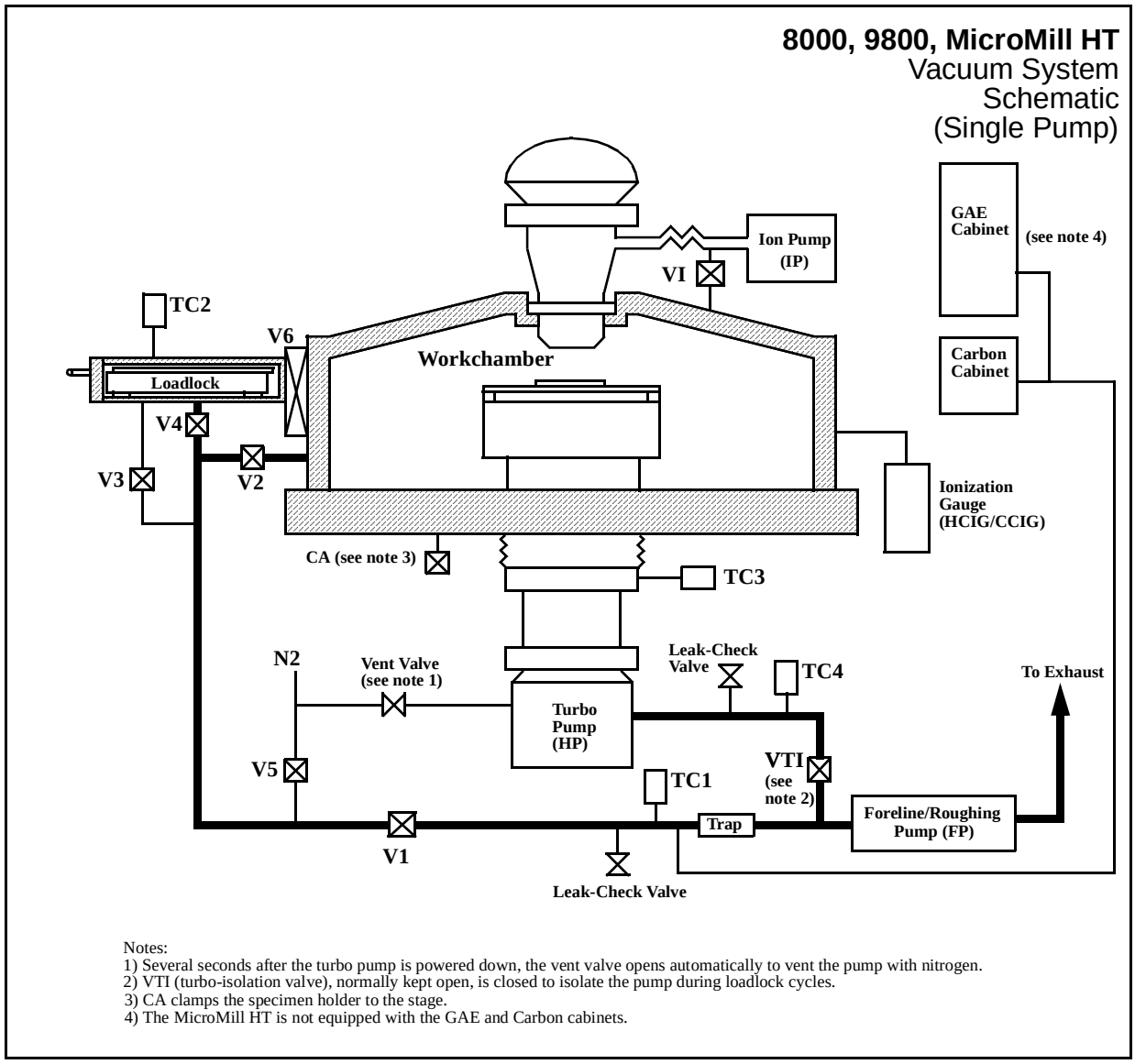
When V2 is opened, there is a burst of rough vacuum from the loadlock into the workchamber (because the workchamber is at a lower pressure than the loadlock). This burst will raise the pressure in the workchamber. In some cases, the system will (as a safety feature) shut down the high voltage (beam), the ion pump, and the HCIG when this burst occurs. To avoid this problem, use the automatic pump down described in Part 1 of this procedure. Shut down is avoided during an automatic pump down because safety checking is temporarily (and automatically) suspended when V2 is opened.

2-27. Check the workchamber pressure by typing:

```
sthc
```

2-28. When the workchamber pressure has reached 3.00×10^{-6} torr, type the following *vacchat* commands:

```
clv2
opv6
```



Notes:
1) Several seconds after the turbo pump is powered down, the vent valve opens automatically to vent the pump with nitrogen.
2) VTI (turbo-isolation valve), normally kept open, is closed to isolate the pump during loadlock cycles.
3) CA clamps the specimen holder to the stage.
4) The MicroMill HT is not equipped with the GAE and Carbon cabinets.

Figure 1. Single Pump Vacuum System

Part 3. Manual Pump Down: Dual (fore and rough) Pump Systems

3-1. Shut the workchamber lid and tighten the "T" screw on the front of the lid (so that the switch block on the lid actuates the switch on the top right of the workchamber).

3-2. Make sure that the turbo pump controller is on and correctly configured. If the controller has not been configured, perform the configuration procedure described in section 4 of Service Procedure 04-05, Turbo Pump Replacement.

3-3. In an xterm window, start the *vacchat* program by typing:

```
vacchat
```

3-4. At the *vacchat* prompt, check the status of the valves by typing:

```
sv
```

The system will display the status of the valves:

```
V1C V2C V3C V4C V5C V6C VIO
```

The valves should be in the states shown above; V1 through V6 and should be closed, and VI should be open (see Figure 2 for valve locations).

If any of the valves V1 through V6 is open, close each valve by typing the *vacchat* close command. For example, V1 is closed with the following command:

```
clv1
```

If VI is closed, open it by typing the following *vacchat* command:

```
opvi
```

3-5. Start the fore pump by typing:

```
fpy
```

3-6. Start the turbo pump by typing:

```
hpy
```

3-7. Wait until the turbo pump reaches its operating speed (42 krpm) before proceeding; this will take approximately 5 minutes. Check the status of the turbo pump by typing the following *vacchat* command:

```
sphp
```

The system will display the status of the turbo pump. If the turbo pump has not reached its operating speed, the system will report:

```
Turbo pump is not ready
```

When the turbo pump has reached its operating speed, the system will report:

```
Turbo pump is ready
```

3-8. When the turbo pump is ready, bring up the hot cathode ionization gauge (HCIG) power by typing[2]:

```
hcpu
```

3-9. After minimal exposure to atmosphere, such as a source change, it should take an hour for the pressure in the workchamber to get below 5.00 x 10^{-6} torr. If the workchamber has been exposed to atmosphere for a prolonged period, it will probably take several hours for the pressure to get below 5.00 x 10^{-6} torr. To check the workchamber pressure, type:

```
sthc
```

3-10. When the workchamber pressure has reached 5.00 x 10^{-6} torr, start the ion pump with the following command:

```
ipy
```

The ion pump housing should be cool to the touch. If the housing is hot, turn off the ion pump and check for problems in the vacuum system.

3-11. To check the ion pump pressure, type:

```
spip
```

The ion pump pressure sensor will not read pressures above 5.00 x 10^{-6} torr; it will display a reading of 5.00 x 10^{-6} torr until the ion pump pressure is below 5.00 x 10^{-6} torr.

3-12. When the workchamber pressure has reached 3.00 x 10^{-6} torr, close VI with the following command:

```
clvi
```

The system will not enable high voltage until the ion pump pressure is below 3.75 x 10^{-6} torr. The amount of time it takes to pump down (to pressures of 3.75 x 10^{-6} torr and below) is dependent upon the cleanliness of the column.

3-13. Tighten the workchamber lid bolts.

Note: this concludes the manual pump down of the workchamber. The remainder of this section describes the manual pump down of the loadlock, and assumes that the workchamber has been pumped down, the fore and turbo pumps are running, and that the high voltage is enabled.

3-14. Close the loadlock door.

3-15. Start the rough pump by typing:

```
rpy
```

3-16. Open V1 with the following *vacchat* command:

```
opv1
```

3-17. Open V3 by typing:

```
opv3
```

---

[2] Some FIB systems have CCIGs rather than HCIGs; the commands `ccpu` or `hcpu` will work on either type.

Opening V3 begins the evacuation of the loadlock through a small diameter vacuum line, and at a relatively low flow rate; this reduces the amount of particulate contamination generated by the evacuation of the loadlock.

3-18. Open V4 by typing the following *vacchat* command:

```
opv4
```

Opening V4 continues the evacuation of the loadlock through a large diameter vacuum line.

3-19. Close V3 with the following *vacchat* command:

```
clv3
```

3-20. Check the status of TC2 by typing:

```
stt2
```

Wait until TC2 < 0.065 torr.

3-21. Close V1 by typing:

```
clv1
```

3-22. Turn off the rough pump by typing:

```
rpn
```

3-23. Open VTP with the command:

```
opvtp
```

3-24. Open V2 with the command:

```
opv2
```

When V2 is opened, there is a burst of rough vacuum from the loadlock into the workchamber (because the workchamber is at a lower pressure than the loadlock). This burst will raise the pressure in the workchamber. In some cases, the system will (as a safety feature) shut down the high voltage (beam), the ion pump, and the HCIG when this burst occurs. To avoid this problem, use the automatic pump down described in Part 1 of this procedure. Shut down is avoided during an automatic pump down because safety checking is temporarily (and automatically) suspended when V2 is opened.

3-25. Check the workchamber pressure by typing:

```
sthc
```

3-26. When the workchamber pressure has reached 3.00×10^{-6} torr, type the following *vacchat* commands:

```
clv2
opv6
```

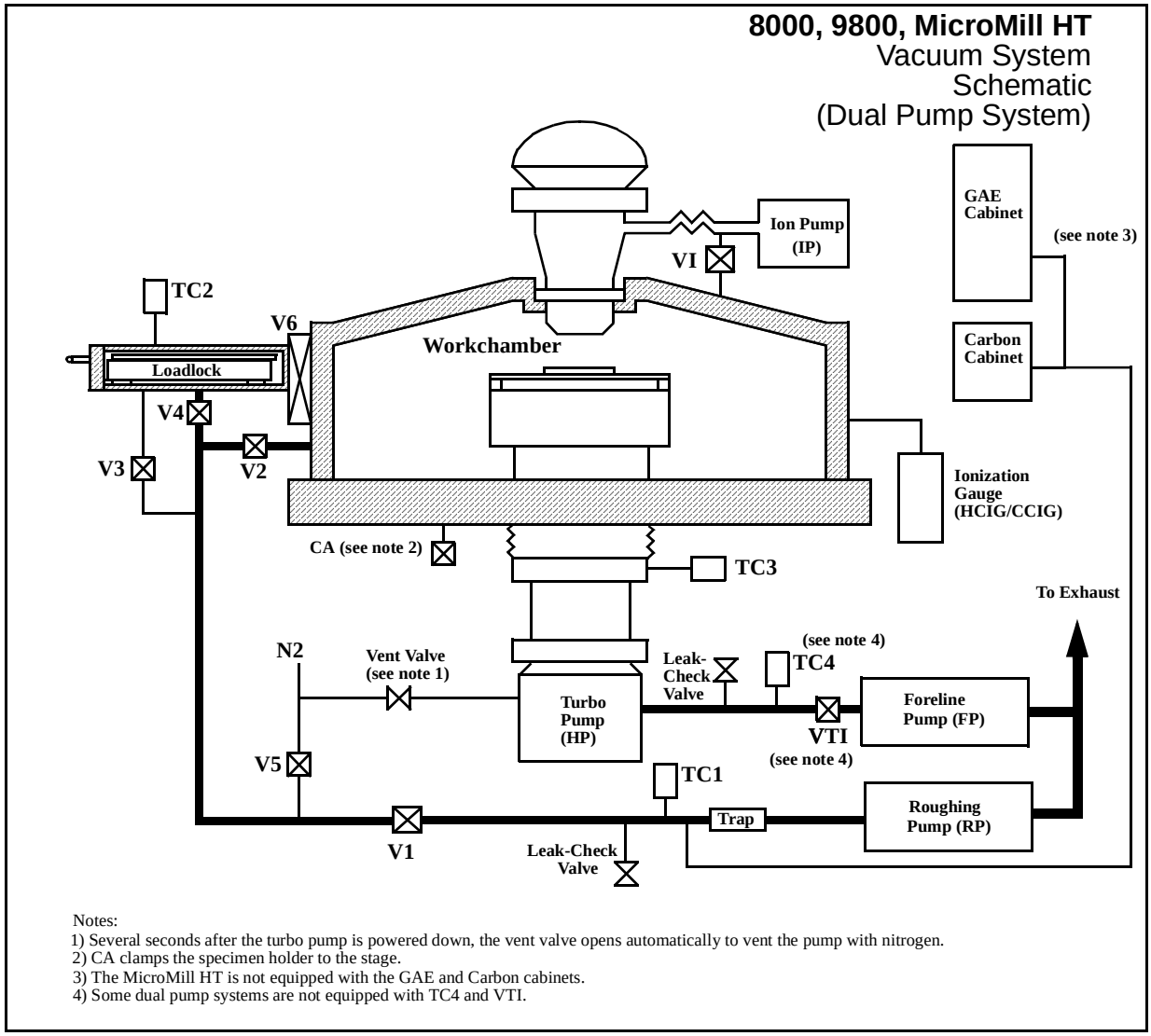


Figure 2. Dual Pump Vacuum System

Micrion

Service Procedure No.: **04-04**
Service Procedure Title: **Roughing/Fore Pump Inspection and Oil Change**
Applicable Systems: **8000, Micrion 9800 FlipChip, MicroMill HT**
Frequency of Service: **Inspect Oil Level and Condition Weekly, Change Oil Every 6 Months**

Introduction

Two types of foreline/roughing pump systems are installed on FIB systems:

- A single (foreline/roughing) pump system that does not require periodic maintenance.
- A dual pump system with separate foreline and roughing pumps. The roughing pump in this system (a Varian chemical series mechanical vacuum pump, Micrion part no. 310-040) requires an inspection every week and an oil change every 6 months.

Materials Required

This procedure requires the use of the following materials:

- Standard field service engineer's tool kit
- Flashlight
- Lint free wipes
- Nitrile rubber gloves (chemical resistant)
- Splash-resistant safety goggles
- Container for waste oil (funnel and sealable vessel for disposal)
- 1 liter of Fomblin ™ (perfluoride polyether), Micrion part no. 320-00104 (for chemical series mechanical pumps only)

Part 1. System Preparation

Configure the Chemical Sources in "Safe" Mode

Before performing the tasks described in this procedure, you must put the chemical sources in a "safe" mode; see Service Procedure 02-01.

WARNING

Do not proceed until the chemical sources are secure. The chemical reservoirs in FIB systems contain hazardous materials. Labels affixed to the exterior of a chemical cabinet identify the chemical(s) contained inside. If a chemical source is not in its "safest" state, as described in **Service Procedure 02-01**, it is possible for a combination of component failures to release the chemical(s) through a cabinet's delivery line, a roughing line, a purging line, or from a chemical reservoir into the workchamber. Do not open the workchamber, or disassemble any part of the vacuum pumping system, or detach any gas line from any chemical cabinet until you are sure that every chemical source attached to the FIB system is in its "safest" state.

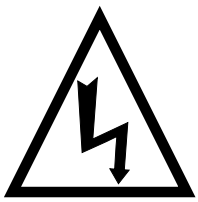
WARNING

Per paragraph 11.1 of Safety Guidelines for Semiconductor Manufacturing Equipment (S2-93), this procedure is a Type 3 task. Specifically:
"Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are greater than 30 volts RMS, 42.2 volts peak, 240 volt-amps, and 20 Joules."

Power Down the System

Before performing the tasks described in this procedure, you must power down the system; see Part 2 of Service Procedure 01-02.

WARNING



Dangerously high voltages are present in the process module while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and automatic procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

Part 2. Prepare the Pumps

2-1. Locate the roughing/fore pump module (typically located behind the process module).

2-2. Remove the pump module enclosure.

a. Remove two screws from each side of the enclosure (see Figure 1).

b. Carefully lift the enclosure to expose the rough pump and the fore pump.

The rough pump has a tan rubberized canvas hose connected to its input. A metallic mesh hose connects the fore pump to the output of the turbo pump.

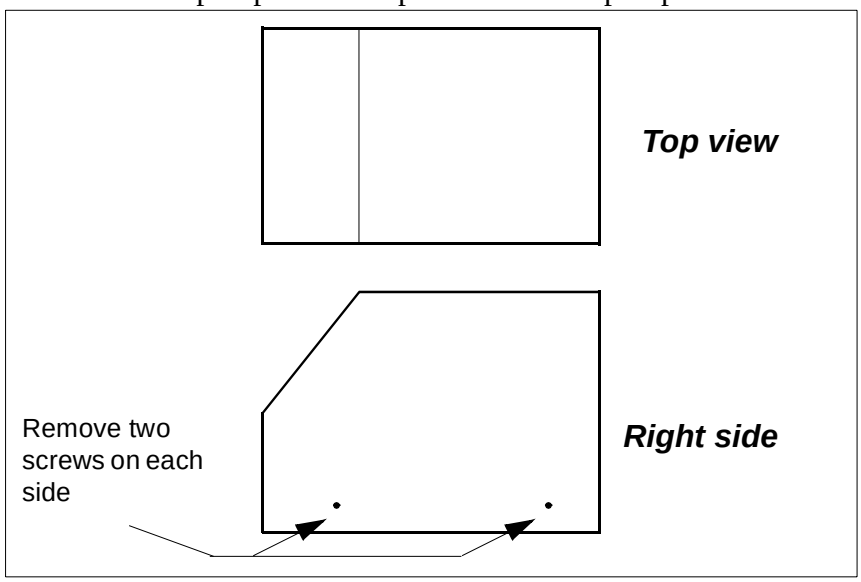


Figure 1. Pump Enclosure.

Part 3. Making a Visual Inspection

The condition and level of the rough pump synthetic oil (Fomblin) must be inspected weekly. To obtain an accurate reading, check the oil level while the pump is hot and turned off. Oil consumption depends upon frequency of pump shutdown and operating pressure.

Oil Color

For chemical series mechanical pumps with Fomblin, a visual inspection of the oil helps determine the degree of oil contamination.

3-1. With the pump off, use a flashlight to examine the oil through the sight glass.

- The level should be in the center of the glass, and the oil should be a clear amber color.
- If the oil is cloudy or brown in color, it is contaminated with condensable vapors and should be changed. See Figure 2 for location of pump reference points.
- Fomblin (perfluoride polyether) does not discolor due to contamination or age as readily as the oil in standard series mechanical pumps.
- Because the sight window becomes coated with the Fomblin after a period of time, the oil may appear to be discolored or opaque when it is not.

- If the pump oil is amber in color but is below the center of the sight glass, add synthetic oil (Fomblin) through the pump fill plug. Use Fomblin ™ (perfluoride polyether), Micrion part no. 320-00104.

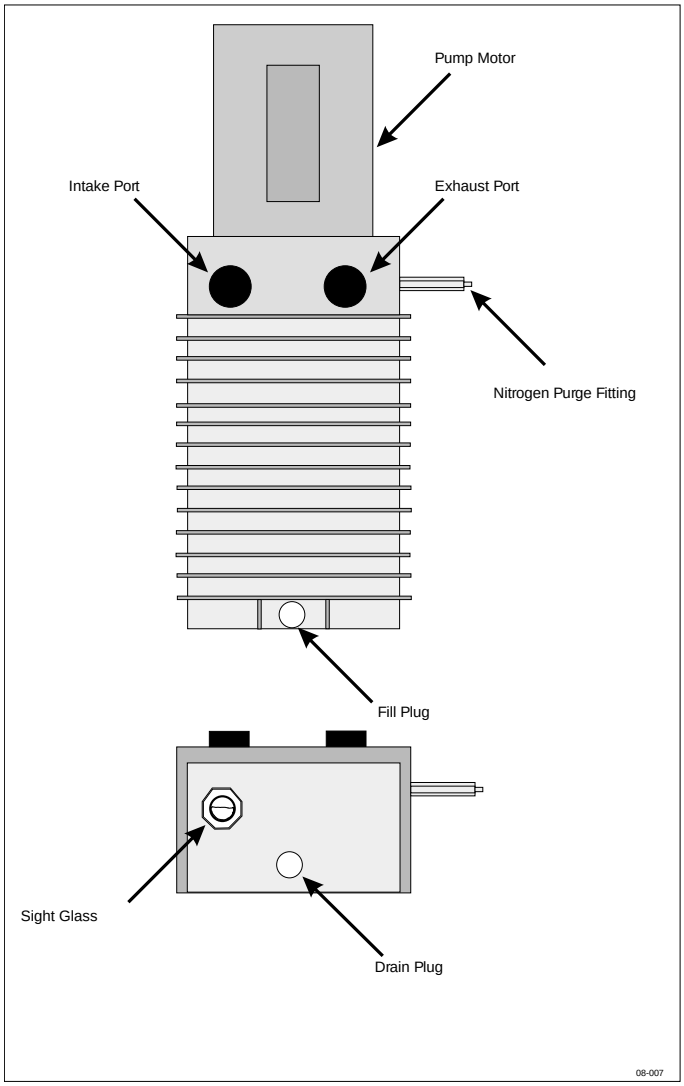


Figure 2. Mechanical Rough Pump, Top and Front Views.

Figure 3 shows the dual pump vacuum system (and the rough pump):

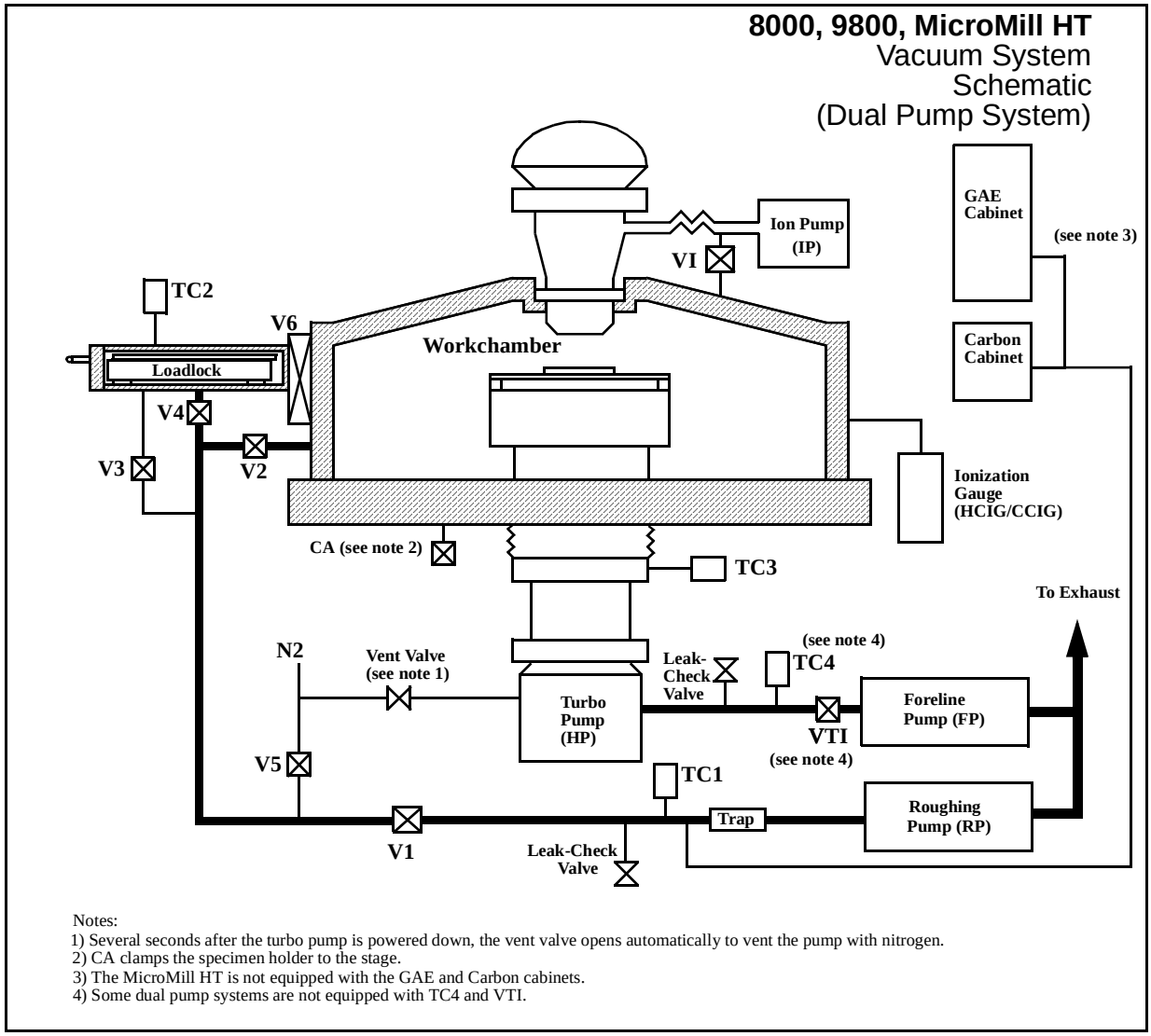


Figure 3. Dual Pump Vacuum System

Part 4. Changing Oil: Chemical Series Mechanical Pumps

CAUTION

Wear chemical resistant nitrile gloves and splash resistant safety goggles while performing these steps. Minimize direct exposure to the chemicals trapped in the pump oil.

CAUTION

Perform this procedure in a well ventilated area. The contaminated waste oil is hot, and may contain toxic materials, including xenon difluoride, styrene, siloxane, chlorine, and bromine. Do not breath in the oil vapors directly. Abide by all safety regulations set forth by the facility for handling and disposing of contaminated waste oil.

4-1. The following instructions provide a step by step procedure for changing the oil in Varian chemical series mechanical pumps.You do not have to vent the system to change the rough pump oil.

4-2. Use the *vacchat* program to close V1 (also close V2, V3, V4, and V6 as a precaution). Allow the pump to run for one hour to bring the oil to the proper temperature.

4-3. Turn off the rough pump through *vacchat* (`rpn`) after the oil is at temperature. Remove the clamp and seal assembly from the intake port. Remove any bolts securing the pump to the base.

CAUTION

Use care when lifting and moving the pump. The rough pump weighs approximately 60 pounds (28 kg). To avoid personal injury, secure the help of another person.

4-4. Remove and place the pump on an elevated stand.

4-5. Place a bottle and a funnel beneath the drain plug, remove the plug, and allow the oil to drain. Remove the fill plug to allow the oil to drain more quickly. See Figure 4.

4-6. With the oil still draining, run the pump for 10 to 15 seconds to expel any oil remaining inside the pump stages.

4-7. Replace the drain plug.

NOTICE: OIL DISPOSAL

Dispose of the old oil in accordance with the customer's specified procedure. If there is no procedure in effect, ask the chemical safety officer or facility manager. If these options are not available, contact Micrion Product Support for further instructions.

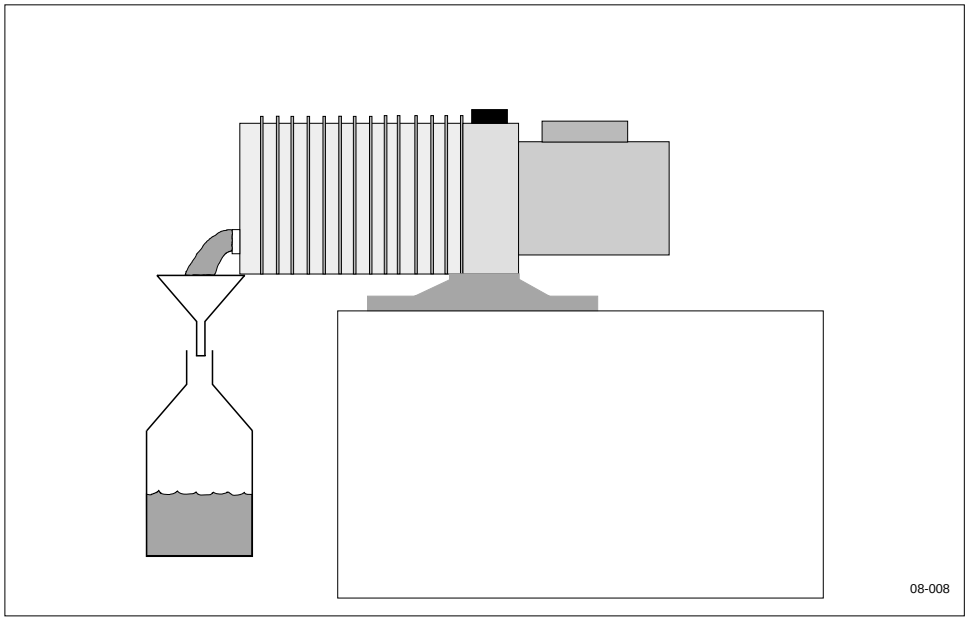


Figure 4. Draining Rough Pump Oil.

4-8. Refill the pump by pouring approximately 0.8 liter (0.85 quart) of new oil through the fill hole on the top of the pump.

- Use Fomblin (perfluoride polyether), Micrion part no. 320-00104.
- For a proper fill, the oil level should reach the center of the sight glass.

4-9. Replace the filler cap; return the pump to the pump enclosure.

4-10. Check the clamp and seal assembly to make sure it is clean; reattach it to the intake port.

4-11. Return the system to operation. After determining that there are no vacuum or oil leaks, replace the pump enclosure.

Micron

Service Procedure No.: **04-05**
Service Procedure Title: **Turbo Pump Replacement**
Applicable Systems: **8000, Micrion 9800 FlipChip, MicroMill HT**
Frequency of Service: **Every 18 months**

Introduction

This procedure describes how to remove and replace the Varian Turbo-V550 pump.

Materials Required

This procedure requires the use of the following materials:

- Standard field service engineer's tool kit
- V550 Turbo Pump Replacement Kit, Micrion part number 100-012720
- V550 adapter flange, Micrion part number 340-00330

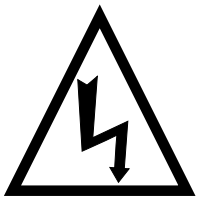
NOTICE

Per paragraph 11.1 of Safety Guidelines for Semiconductor Manufacturing Equipment (S2-93), this procedure is a Type 3 task. Specifically: "Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are less than 30 volts RMS, 42.2 volts peak, 240 volt-amps, and 20 Joules."

Power Down and Vent the System

Before performing the tasks described in this procedure, you must power down and vent the system; see Service Procedure 01-02.

WARNING



Dangerously high voltages are present in the process module while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and automatic procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

Part 1. Prepare for Pump Removal

1-1. Switch off the circuit breakers shown in Figure 1, and switch off the power at the turbo pump controller on the bottom right of the electronics console.

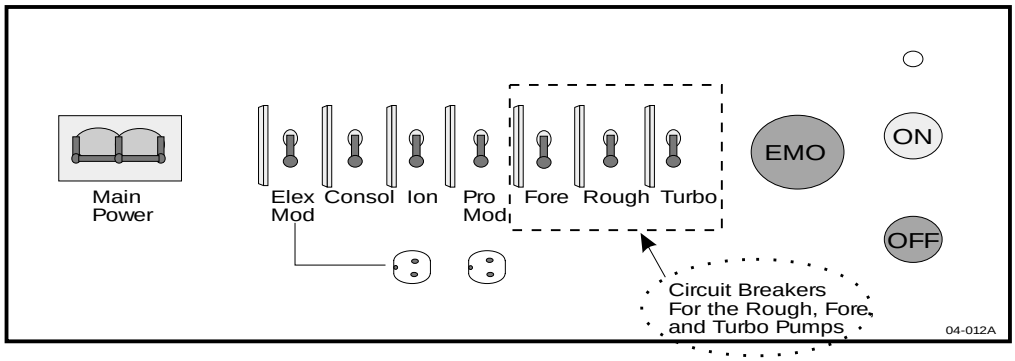


Figure 1. Power Distribution Panel, Top Right of Electronics Module

1-2. While the turbo pump is spinning down, perform the following tasks:

a. Turn off the water supply to the turbo pump.

b. Remove the enclosure panels from the system.

c. Remove the front bottom kick plate.

1-3. Disconnect the circular power connector from the turbo pump (see Figure 2).

1-4. Disconnect the turbo pump exhaust line (the line between the turbo pump and the roughing/fore pump) at the turbo pump exhaust port, leaving the roughing bellows attached to the bulkhead plate (see Figure 2).

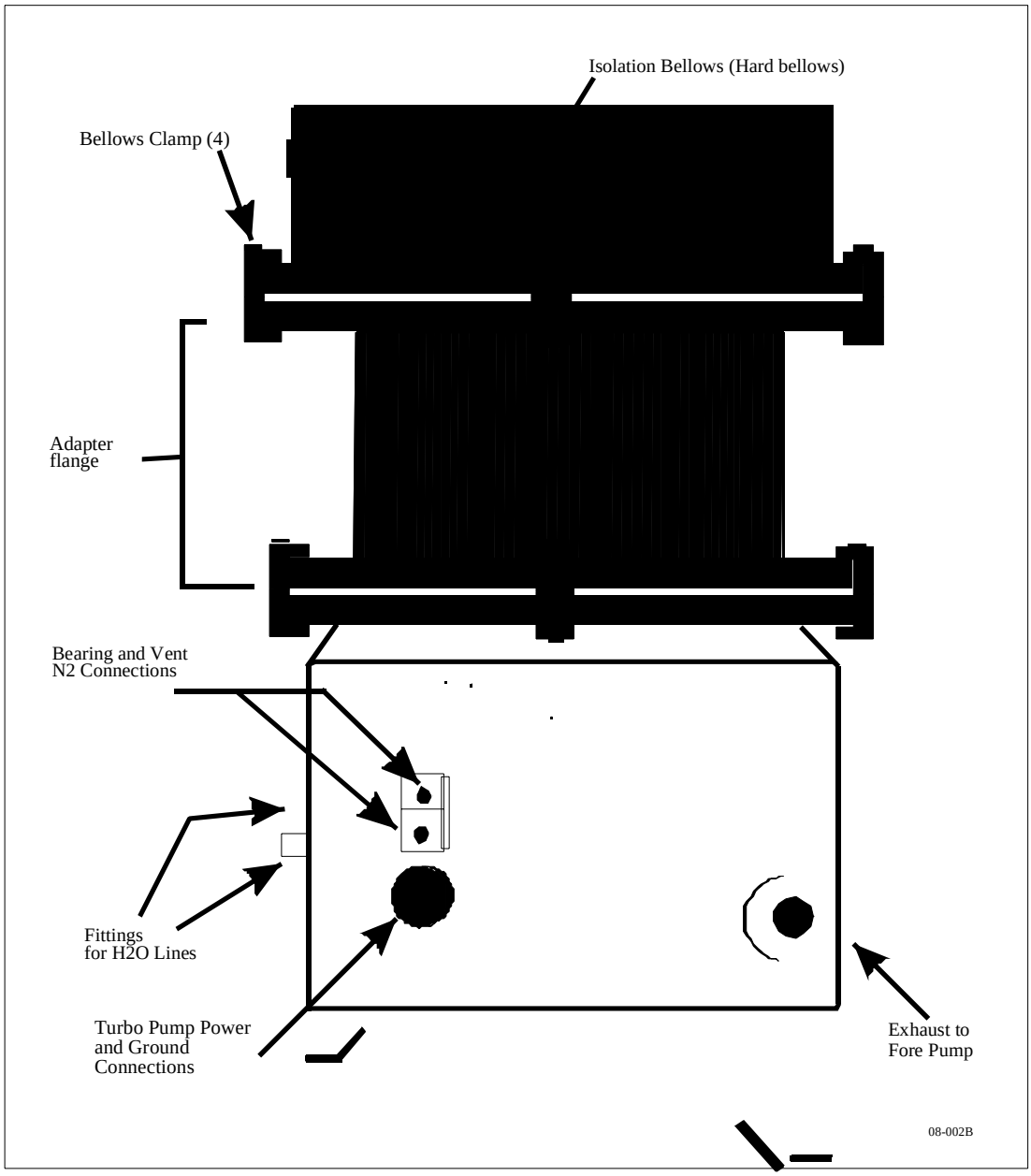


Figure 2. Turbo-V550 Pump

1-5. Remove the double claw clamps from the turbo pump inlet (8" ISO flange) and the turbo pump isolation bellows.

1-6. Switch off the N_2 supply. Remove the N_2 venting device.

1-7. Disconnect the water lines from the inside of the systems bulkhead by removing the hose clamps. It may be necessary to loosen the bulkhead plate to gain access to the connectors. See Figure 3.

Disconnect the water lines from the barb fittings on the turbo pump by cutting the water line tubing as close to the barb fittings as possible.

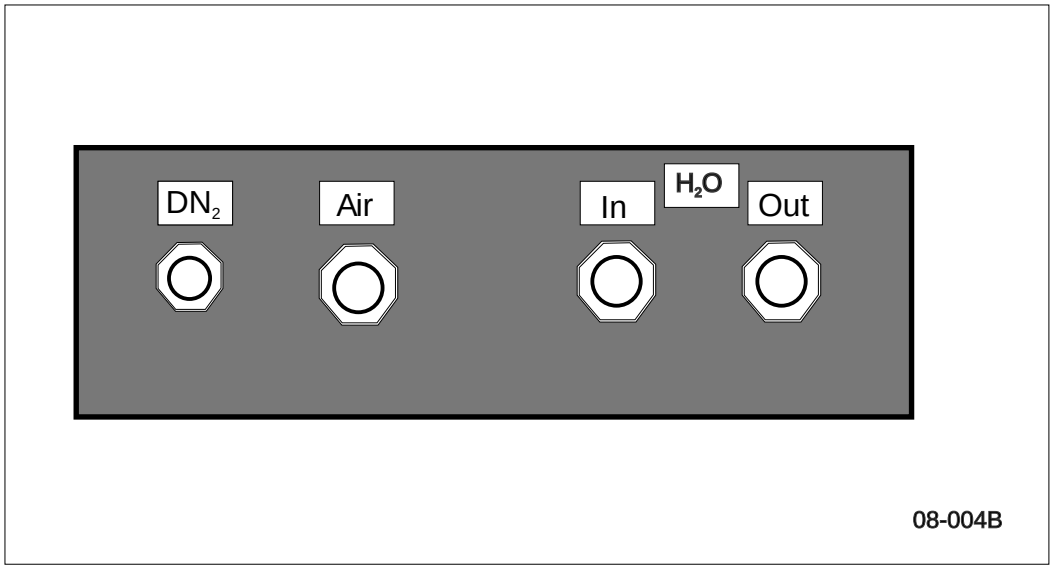


Figure 3. Turbo Pump Bulkhead

The pump is now disconnected from the system.

Part 2. Pump Removal

2-1. Depending on system configuration, there may be some cable harnesses that need to be lifted over the pump.

2-2. Remove the cross piece that is horizontal to the floor connecting the front two legs.

CAUTION

Use care when lifting and moving the pump, which weighs approximately 85 lbs (38.5 kg). To avoid personal injury, secure the help of another person.

2-3. Loosen and remove the hose clamp securing the red vibration-damping collar.

2-4. Loosen the four bellows clamps (see Figure 2).

2-5. Remove the pump from the adapter flange.

2-6. Slide the pump along the base plate towards the front of the system. Be careful to clear the pump inlet screen. You may have to adjust (increase) the air pressure to the isolators (see Service Procedure 08-02) to gain an extra 0.5" (maximum) clearance.

2-7. Package the replaced pump for shipping as specified by the manufacturer or Micrion Product Support. Return the pump to Micrion.

Part 3. Turbo Pump Replacement

3-1. Install the inlet screen on the replacement pump.

3-2. Install the turbo pump bellows on the bottom of the workchamber.

3-3. Use a double-claw clamp to secure the adapter flange to the turbo pump bellows. (See Fig. 2.)

3-4. Slide the replacement pump along the base plate until it is positioned below the adapter flange and bellows.

3-5. Use a double-claw clamp to secure the replacement turbo pump to the adapter flange.

3-6. Connect the water lines using hose clamps.

3-7. Connect the circular power connector to the turbo pump.

3-8. Switch on the N_2 supply.

3-9. Connect the roughing line to the turbo pump roughing port.

3-10. Switch on the circuit breakers shown in Figure 1, and turn on the power at the turbo pump controller on the bottom right of the electronics console.

3-11. Replace the enclosure panels.

3-12. Turn on the turbo pump water supply.

Part 4. Controller Configuration

The following steps describe how to configure the V550 turbo pump through the control box.

4-1. Ensure that the system is totally vented.

4-2. Remove the 9-pin D-connector P1 from the rear of the turbo pump controller. P1 is the top connector to the left of the fan. P1 pins 1-6 and 3-8 are jumpered to create the interlock needed to physically run the pump.

4-3. Switch off the foreline pump circuit breaker (see Figure 1) to cut power to the pump.

4-4. Remove the VTI pneumatic line connection and pinch the end closed with a tie-wrap.

4-5. In *vacchat*, switch on the pump in software with the following two commands:

```
fpy
hpy
```

4-6. Put the turbo pump controller in edit mode by pressing the two top buttons on the turbo pump panel simultaneously. See Figure 4 (Also see Varian's *Turbo-V550 Controller Instruction Manual*).

4-7. Press the top right button (Pump Current) to scroll through the edit menu selections.

4-8. Use the top left button (Cycle Number) to change (toggle) each setting to match the specifications in Table 1.

Table 1: V550 Operating Specifications

Menu Selection	Response
Soft start	NO
Water cooling	YES
Front/Remote/232	Front
RS232 Baud Rate	9600
RS232 Host/Print	Host
Speed Threshold[a]	42 krpm
Run-Up Time	00h 08m 00s
Delay even after threshold	YES
Pump life reset	YES

a. Select "4" by pressing Cycle Number and pressing Pump Current until the number 4 appears. Do the same for the second number, "2". Speed threshold must be equal to or less than the speed adjustment setting for normal operation. Adjust the speed by pressing the two buttons for at least five seconds; you may need to reset the controller first by initiating `hpn` and `fpn` in *vacchat.*

4-9. With P1 still disconnected, give the commands:

```
hpn
fpn
```

4-10. Now reconnect D-connector P1.

4-11. Reconnect the VTI pneumatic line.

4-12. Turn on the foreline circuit breaker at the top right front of the electronics module.

4-13. In *vacchat*, enter the following command to check that the motor speed is equal to or greater than the speed threshold (42 krpm):

```
sphp
```

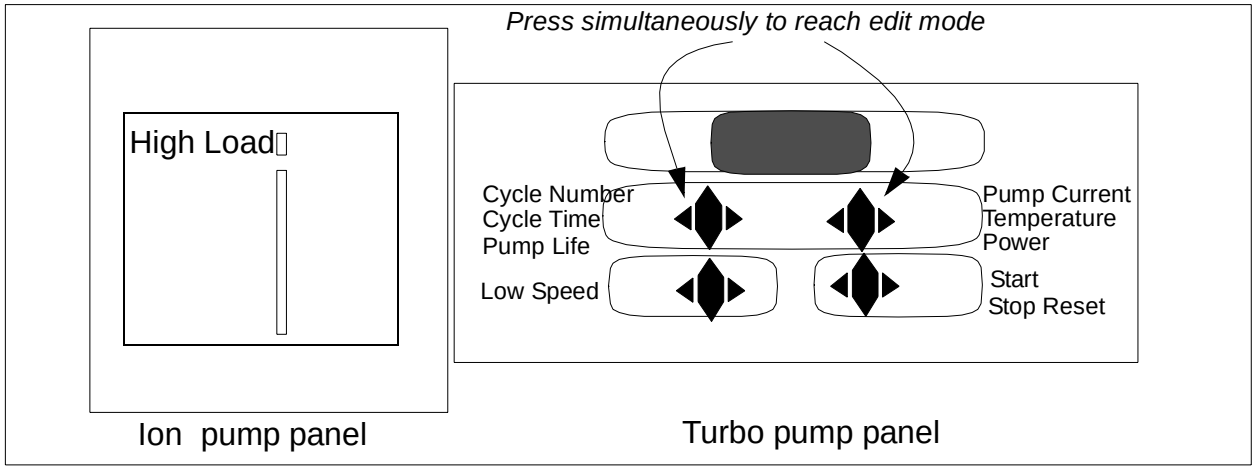


Figure 4. Turbo-V550 Controller Interface

Part 5. Vibration Damping

It may be necessary to tune or adjust the turbo pump bellows clamp once the system is back in operation. Perform this operation using a beam image at high magnification as a diagnostic tool.

The system must be at the “beam up” operating level to perform the following steps.

5-1. Zoom in on a recognizable stage feature such as the silicon grid. Make note of any vibration present in the image.

5-2. To eliminate or minimize any vibration due to the turbo pump, you must adjust the damping material, a lead and foam collar that surrounds the turbo pump bellows. Adjust the bellows as follows to eliminate or minimize any vibration in the image. It may be necessary to repeat these steps several times:

a. Adjust the location of the collar on the bellows.

b. Adjust the tightness of the hose clamp securing the collar.

Micrion

Service Procedure No.: **04-06**
Service Procedure Title: **Foreline Trap Element Replacement**
Applicable Systems: **8000, Micrion 9800 FlipChip, MicroMill HT**
Frequency of Service: **Annually or as Needed**

Introduction

Two types of foreline/roughing pump systems are installed on FIB systems:

- A single (foreline/roughing) pump system that does not include a foreline trap.
- A dual pump system with separate foreline and roughing pumps. A foreline trap is connected to the roughing pump in this system; the trap helps prevent rough pump oil from streaming back into the loadlock. The element in the trap must be replaced on an annual basis. Although the trap is connected in line with the rough pump, it is called the "foreline" trap for historical reasons.

Tools and Materials Required

This procedure requires the use of the following materials:

- Standard field service engineer's tool kit
- Flashlight
- Lint-free cloths
- Chemical-resistant nitrile gloves
- Splash-resistant safety goggles
- Sargent-Welch trap replacement element (Micrion part no. 300-000036)
- Container for disposal of used element

NOTE: All automated programs no longer work in vacserver. This includes autovent, autopump-down, and calabrate functions. This is a temporary situation and will be changed back in the next release of software.

- *vacserver* program

NOTICE

Per paragraph 11.1 of Safety Guidelines for Semiconductor Manufacturing Equipment (S2-93), this procedure is a Type 3 task. Specifically: "Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are less than 30 volts RMS, 42.2 volts

peak, 240 volt-amps, and 20 Joules."

Part 1. System Preparation

Configure the Chemical Sources in "Safe" Mode

Before performing the tasks described in this procedure, you must put the chemical sources in a "safe" mode; see Service Procedure 02-01.

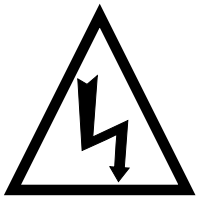
WARNING

Do not proceed until the chemical sources are secure. The chemical reservoirs in FIB systems contain hazardous materials. Labels affixed to the exterior of a chemical cabinet identify the chemical(s) contained inside. If a chemical source is not in its "safest" state, as described in **Service Procedure 02-01**, it is possible for a combination of component failures to release the chemical(s) through a cabinet's delivery line, a roughing line, a purging line, or from a chemical reservoir into the workchamber. Do not open the workchamber, or disassemble any part of the vacuum pumping system, or detach any gas line from any chemical cabinet until you are sure that every chemical source attached to the FIB system is in its "safest" state.

Power Down the System

Before performing the tasks described in this procedure, you must power down the system; see Part 2 of Service Procedure 01-02.

WARNING



Dangerously high voltages are present in the process module while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and automatic procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

Part 2. Locate the Trap

When looking at the module from the front, the foreline trap is located underneath the process module, slightly to the left and rear. It is connected in series between the loadlock and the rough pump.

Part 3. Isolate the Loadlock

NOTE: All automated programs no longer work in vacserver. This includes autovent, autopump-down, and calabrate functions. This is a temporary situation and will be changed back in the next release of software.

3-1. Use the *vacserver* program to close V1 (also close V2, V3, V4, and V6 as a precaution). See Figure 1.

3-2. Turn off the rough pump using *vacserver* command `rpn`.

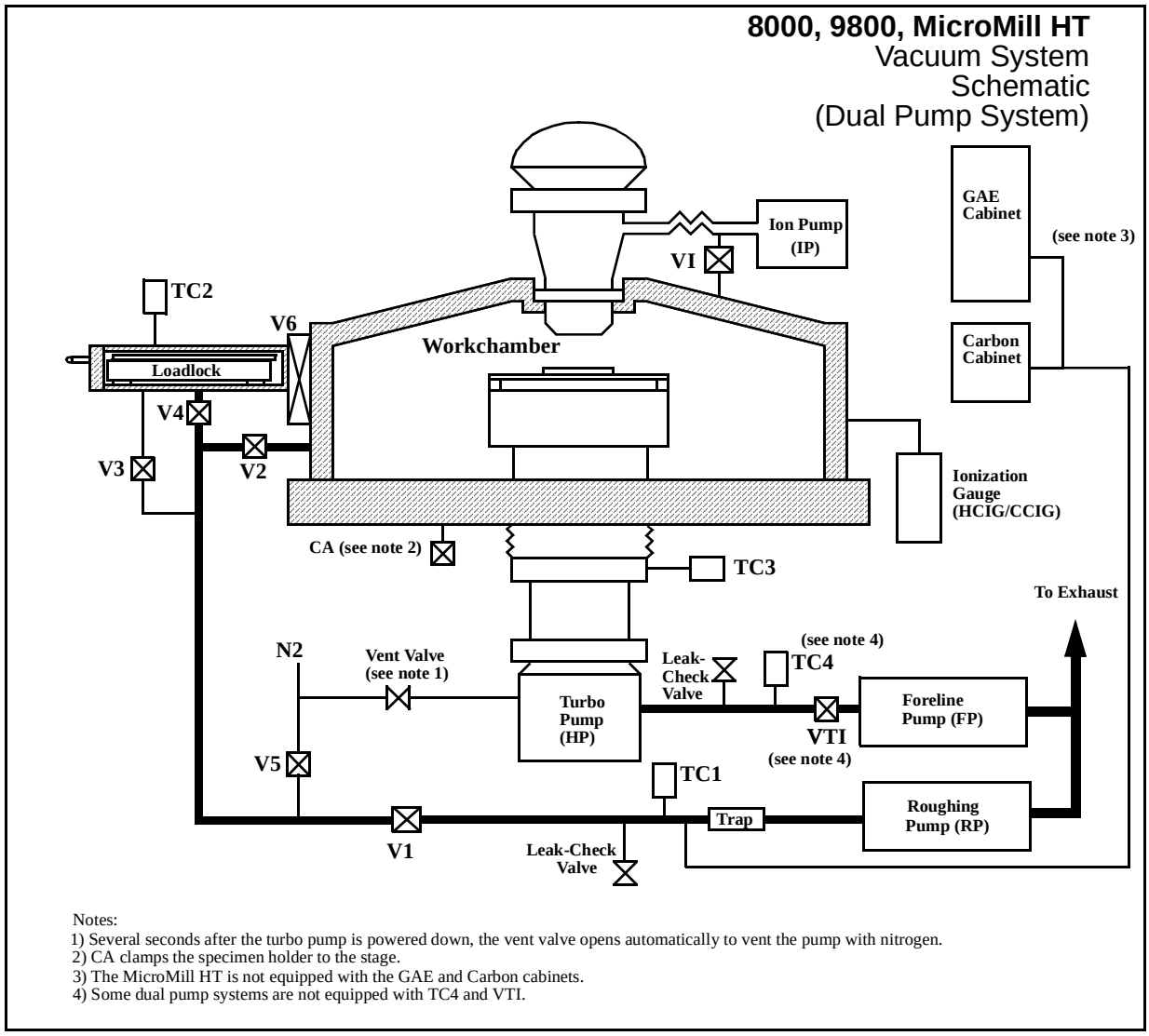


Figure 1. Dual Pump Vacuum System

Part 4. Remove and Replace the Old Trap

4-1. Remove the enclosure panels from the system. You may only have to remove the front, rear, and left side panels (as viewed from the front of the process module) or some combination of these to gain access to the foreline trap.

WARNING

Wear nitrile, chemical resistant gloves and protective, splash-resistant safety goggles while performing the following tasks. Exercise extreme caution and perform this procedure in a well ventilated area. Do not breath in the oil vapors directly. Abide by all safety regulations for handling contaminated waste oil.

4-2. To provide free access to the trap, be sure that the area around the foreline trap is clean and uncluttered. Gain access to the trap either from the front or the rear of the process module, whichever is easier.

If necessary, vacuum underneath the system to prevent contamination of the vacuum system while the lines are disconnected.

4-3. With the rough pump off, disconnect the trap cover. The trap cover is connected to the loadlock vacuum line.

Use Figure 2 to locate the assemblies referenced in the following steps.

a. Unfasten the KF clamp at the bottom of the bellows assembly.

b. Unfasten the latch on the clamp that secures the trap cover.

c. Carefully remove the trap cover and place it on a clean, lint free cloth.

d. Reach into the trap and remove the oily, copper mesh element. Place the element in a plastic bag immediately. Do not contaminate any other surfaces with the oily residue.

e. Insert the new element (Micrion part no. 300-000036) into the trap.

f. Inspect the cover to make sure the gasket and mating surface are clean and properly seated.

g. Replace the trap cover and close the clamp that secures it.

h. Inspect the gasket and mating surface at the KF clamp on the bellows assembly for nicks and scratches.

i. Reconnect the bellows assembly to the cover and secure the KF clamp.

4-4. After all the vacuum lines are reconnected, make sure that there are no leaks, and return the system to its normal state.

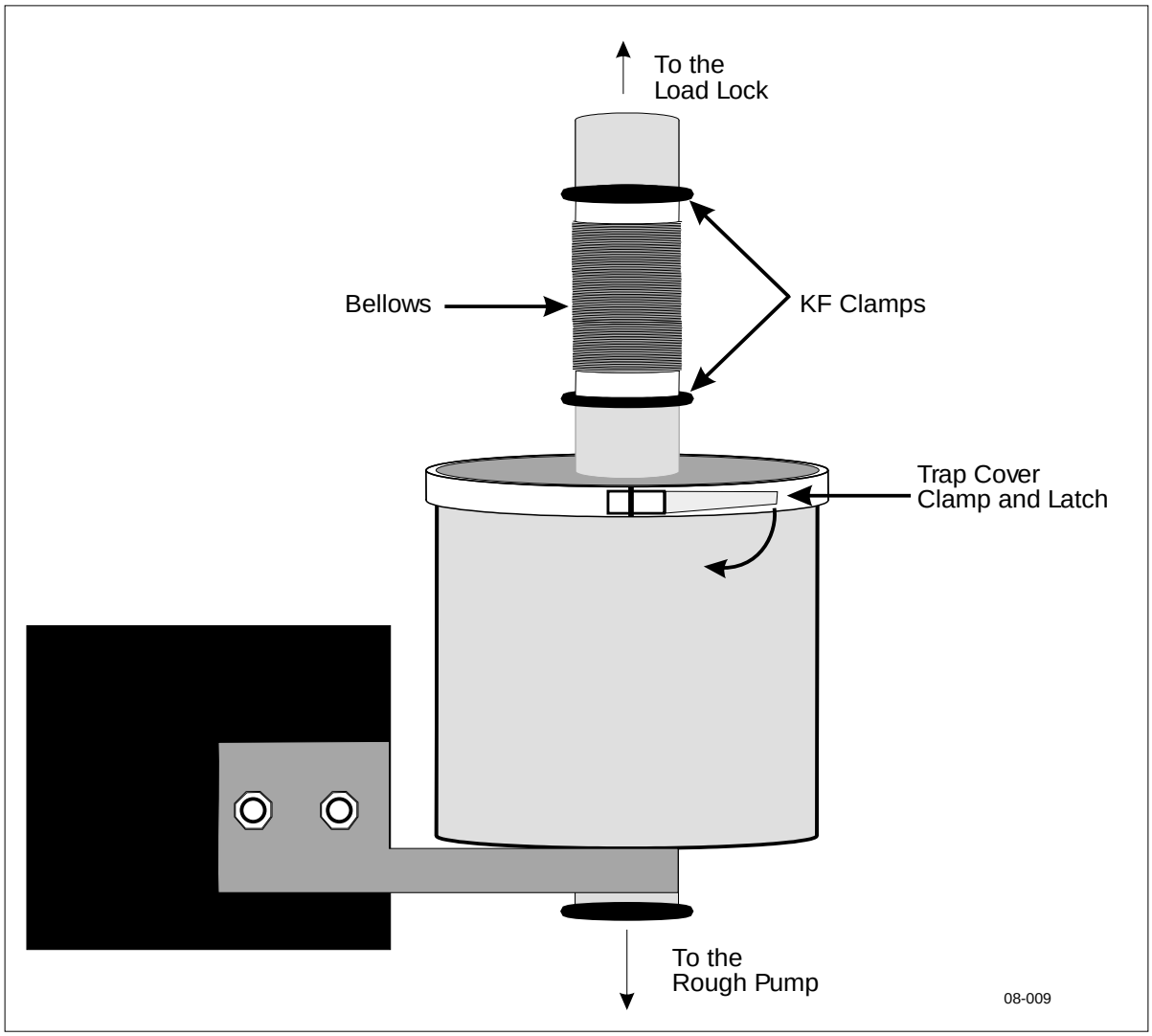


Figure 2. The Foreline Trap.

Micrion

Service Procedure No.: **04-07A**
Service Procedure Title: **EPROM Upgrade and Thermocouple Calibration**
Applicable Systems: **All**
Frequency of Service: **As needed**

Introduction

This procedure concerns the swapping of EPROMs on the VacCon Computer board, and the setting of thermocouple defaults in the Vacuum.M file. Also included are details on preparing for the thermocouple calibration.

Tools and Materials Required

- *Vacchat* Software
- VacCon Computer board (Micrion part no. 100-009290)
- Upgrade EPROM

Part 1. Swapping EPROMs from the VacCon Computer Board

The VacCon Computer board is normally in the second or third slot from the left end of the VacCon module. You can identify it by the part number, 100-009290, on the white sticker on the ejector tab. Be sure to power down the VacCon before handling the board.

1-1. Switch off the VacCon module. (See Service Procedure 01-02.)

1-2. Disconnect the two connectors from the VacCon Computer board.

1-3. Remove the VacCon Computer board from the VacCon module.

1-4. Remove the EPROM, U11; it is a 32-pin IC located on the upper left quadrant of the board.

1-5. Insert the new EPROM in the socket at U11.

1-6. Replace the VacCon Computer board and reconnect the two connectors.

1-7. Switch on the VacCon Module.

Part 2. Setting the TC Defaults in the Vacuum.M File

You must now specify the default values for the thermocouple calibration constant, to be read by the new EPROM.

2-1. In the Vacuum.M file, set the default value FF for each of the four thermocouples:

```
tc1_cc          0               "FF"
tc2_cc          0               "FF"
tc3_cc          0               "FF"
tc4_cc          0               "FF"
```

2-2. Save the file.

Part 3. Preparing for Thermocouple Calibration

To prepare for the calibration of the thermocouples, pump down the system and start Microsurgery.

3-1. Pump Down to an operating vacuum level. (See Service Procedure 04-03).

3-2. Start *Microsurgery.*

Refer to Service Procedure 04-07B.

Micrion

Service Procedure No.: **04-07B**
Service Procedure Title: **Thermocouple Calibration**
Applicable Systems: **All**
Frequency of Service: **Semiannually; and at the installation of a new system or a new TC**

Introduction

The readout from a thermocouple (TC) may vary due to manufacturing tolerances or to chemical contamination. As a result, for example, a pressure of 0.001 torr may be reported by a TC as 0.020 torr.

This procedure describes the manual method for calibrating a thermocouple.

The way to calibrate a thermocouple is to measure its error and then enter it in the Vacuum.M file. The computer then calculates the ratio of the error to the "base" pressure (i.e., the lowest possible pressure from that portion of the vacuum system), and uses this ratio to determine the correct readout.

The steps in the procedure are as follows:

- Determining the number of thermocouples installed
- Pumping down the system to an assumed base pressure (e.g., for TC3, 0.001 torr)
- Reading the value of each thermocouple
- Editing the Vacuum.M file with the new value

Tools and Materials Required

- *Vacchat* Software

Part 1. Determining the Number of Thermocouples

1-1. In an xterm window running the *vacchat* program, type the thermocouple status command:

```
st
```

The screen displays all thermocouples. Each of them must be calibrated separately.

Part 2. Pumping Down to the Base Pressure

One at a time for each thermocouple, pump down its specific area until you are sure from experience that the base pressure has been reached. For example, for TC3, run the turbo pump until you are sure that the pressure is 0.001 torr or below. Then you can confidently assume that the reading from TC3 *should* be 0.001 torr.

Part 3. Reading the Value of a Thermocouple

3-1. In a *vacchat* window, type the follow commands:

`su` (and password)

`idy`

`wrb0=01`

`rdb#` (where # is the number of the thermocouple)

`idn`

3-2. Record the hexadecimal value of the readout from the `rdb#` command.

3-3. With the following command, send this hexadecimal value, known as the calibration constant, to the computer:

`cct#nn` (where nn is the calibration constant from step 3-2)

Part 4. Editing the Vacuum.M File

4-1. In the Vacuum.M file, change the calibration constant on the following line:

`tc#_cc 0 "nn"` (where nn is the calibration constant)

4-2. Save the file and restart *vacchat*.

The computer calculates the correct ratio from this point until the next calibration; the TC readout will then be accurate. Shown in Fig. 1 is a graph comparing readout and pressure for an ideal TC (solid line) with the readout and pressure for a typical TC (dashed line). On the horizontal scale the readout of the thermocouples is seen as an eight-bit A/D converter; on the vertical scale is a range of torr from 2.50 torr to 0.001 torr. The hypothetical ratio shown in the figure can be used by the computer to adjust the readout.

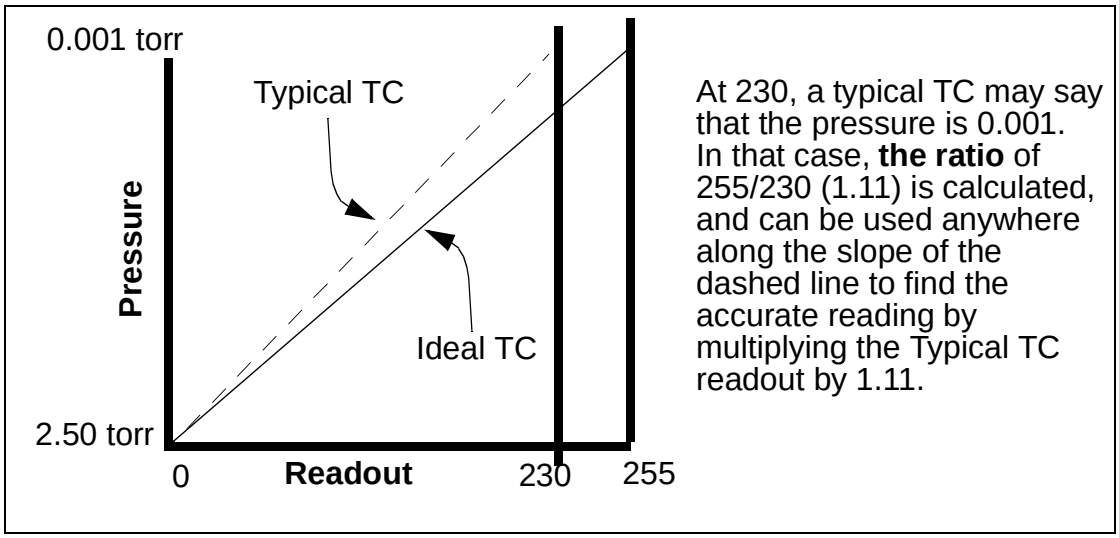

0.001 torr
Typical TC
Pressure
Ideal TC
2.50 torr
0
Readout
230
255
At 230, a typical TC may say that the pressure is 0.001. In that case, **the ratio** of 255/230 (1.11) is calculated, and can be used anywhere along the slope of the dashed line to find the accurate reading by multiplying the Typical TC readout by 1.11.

Figure 1. Example of the ratio of an ideal TC reading and a typical reading

Section 5: Column

- 05-01 Column Parameter Log
- 05-02-05 Cleaning Column (Lens 2) Elements: 5 nm Column
- 05-02-10 Cleaning Column (Lens 2) Elements: 10 nm Column
- 05-02-25 Cleaning Column (Lens 2) Elements: 25 nm Column
- 05-03-05 MCP Removal and Replacement: 5 nm Column
- 05-03-10 MCP Removal and Replacement: 10 nm Column
- 05-03-25 MCP Removal and Replacement: 25 nm Column
- 05-04-05 Flood Gun Removal and Replacement: 5 nm Column
- 05-04-10 Flood Gun Removal and Replacement: 10 nm Column
- 05-04-25 Flood Gun Removal and Replacement: 25 nm Column
- 05-05 Aperture Limit Switch Inspection
- 05-06 External Aperture Inspection and Lubrication
- 05-07 Aperture Replacement
- 05-08 Aperture Milling Table Test (N/A; not included)
- 05-09-05 Column Removal and Replacement: 5 nm Column
- 05-09-10 Column Removal and Replacement: 10 nm Column
- 05-09-25 Column Removal and Replacement: 25 nm Column
- 05-10 Ion Source Change
- 05-11 Gallium Source Heating
- 05-12-05 Column and Lens Curing
- 05-12-10 Column and Lens Curing
- 05-12-25 Column and Lens Curing
- 05-13 Column Alignment
- 05-14 Drift Test
- 05-15-05 Aperture Shield Removal, Inspection, and Replacement: 5 nm Column
- 05-15-10 Aperture Shield Removal, Inspection, and Replacement: 10 nm Column
- 05-15-25 Aperture Shield Removal, Inspection, and Replacement: 25 nm Column
- 05-16-05 Blanking Aperture Replacement: 5 nm Column
- 05-16-10 Blanking Aperture Replacement: 10 nm Column
- 05-16-25 Blanking Aperture Replacement: 25 nm Column

Micrion

Service Procedure No.: **05-01**
Service Procedure Title: **Column Parameter Log**
Applicable Systems: **All**
Frequency of Service: **Daily**

Introduction

To increase your ability to plan maintenance procedures and diagnose system failures, record the column parameters daily in Table 1, “Column and System Parameters,” on page 2. This record reveals performance trends that help you to maintain and service the machine. The procedure begins with the beam up.

Part 1. Procedure

1-1. On the Microsurgery screen[1] (Mask Repair screen for 8000), select the Beam Control screen from the Tasks menu.

1-2. In the Beam Control screen, turn on Readback Update.

1-3. From the screen display, record the following parameters in Table 1, “Column and System Parameters,” on page 2:

- acceleration voltage
- extractor voltage
- extractor current (in the blue box beside the extractor voltage)
- suppressor voltage

1-4. Open the Stage Control dialog box by clicking the blue box in the Control window (to the right of the Image window).

1-5. In the Control window, set the (imaging) Mode to Ion.

1-6. Open the Electron Flood Gun Control popup by clicking the flood gun graphic (outside the upper right corner of the image window, shaped like an L-bracket).

1-7. To see the column diagram, drag the dialog box to the right.

1-8. On the column diagram, click on the beam-limiting aperture graphic to open the Beam Limiting Aperture Control popup; drag it so that you can view all the open popups. You will need to use the *Size* button to change apertures as you continue.

---

[1] The Microsurgery program is provided for access to certain maintenance functions. To start it, type `surgery` in an xterm window.

1-9. Record the following parameters for all apertures in Table 1.

- blanking aperture current reading
- MCP (detector) gain voltage
- Ion Faraday and Electron Faraday current
- Electron Flood Gun filament and cathode current

Table 1: Column and System Parameters

Date:	By:	
Parameter	**Value**	**Unit**
Acceleration Voltage		keV
Extractor Voltage		V
Extractor Current (The blue box next to the Extraction Voltage readout.)		µA
Suppressor Voltage		V
Blanking Aperture Current (On the column diagram, click the *Blanking Aperture* read-back numbers.)		µA
MCP Gain Voltage (Refer to the column diagram.)		V
Ion Faraday Current (Click the *Ion Faraday* push-button below the image window)		µA
Electron Faraday Current (Click the *Elec Faraday* push-button below the image window)		µA
Flood Gun Filament Current (See the Electron Flood Gun Control popup.)		µA
Flood Gun Cathode Current (See the Electron Flood Gun Control popup.)		µA
Beam Current (Brightness, for EX systems)		nA
Fluid: Valve Air		psi
Fluid: Isolator Air		psi
Fluid: DN_2		psi

Micrion

Service Procedure No.: **05-02-05**
Service Procedure Title: **Cleaning the Lower Column (Lens 2) Elements: 5 nm Column**
Applicable Systems: **8000, Micrion 9800 FlipChip, MicroMill HT Systems**
Frequency of Service: **As Needed**

Introduction

When the workchamber is vented the column elements may become contaminated. For the system to maintain optimal performance, the column elements must be free of contaminants. Be careful not to damage any part of the column during the cleaning procedure: any scratches will ruin the lower column (Lens 2) elements, and any metal tracks left on ceramic surfaces cause serious problems with the column operation. Clean the column elements only if you are reasonably certain that they have become contaminated.

Required Materials

This procedure requires the following materials:

- Clean room, preferably with a class 100 airflow hood; however, a properly cleaned and prepared work area will be sufficient
- Clean, standard field service tools (completely free of oil and grease)
- Lint-free wipes
- Clean-room gloves
- High intensity light source
- Aluminum foil
- Clean lens brush
- Clean, filtered dry nitrogen (an ionizing N_2 gun with at least 20 psi is preferred)
- Cotton-tipped applicators

NOTICE

Per paragraph 11.1 of *Safety Guidelines for Semiconductor Manufacturing Equipment* (S2-93), this procedure is a Type 3 task: “Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are less than 30 volts RMS, 42.2 volts peak, 240 volt-amps, and 20 Joules.”

NOTICE: TRAINING IS REQUIRED FOR THIS PROCEDURE

Do not attempt to perform this procedure unless you have been properly trained. Only qualified personnel should perform this procedure.

Part1. System Preparation

Configure the Chemical Sources in "Safe" Mode

Before performing the tasks described in this procedure, you must put the chemical sources in a "safe" mode; see Service Procedure 02-01.

WARNING

Do not proceed until the chemical sources are secure. The chemical reservoirs in FIB systems contain hazardous materials. Labels affixed to the exterior of a chemical cabinet identify the chemical(s) contained inside. If a chemical source is not in its "safest" state, as described in **Service Procedure 02-01**, it is possible for a combination of component failures to release the chemical(s) through a cabinet's delivery line, a roughing line, a purging line, or from a chemical reservoir into the workchamber. Do not open the workchamber, or disassemble any part of the vacuum pumping system, or detach any gas line from any chemical cabinet until you are sure that every chemical source attached to the FIB system is in its "safest" state.

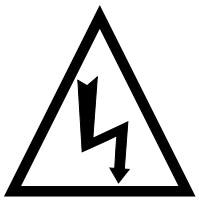
NOTICE: CLEAN THE SURROUNDING AREA

Before you vent the system, clean the exterior of the process module and surrounding area. The column is very sensitive to contamination.

Power Down and Vent the System

Before performing the tasks described in this procedure, you must power down and vent the system; see Service Procedure 01-02.

WARNING



Dangerously high voltages are present in the process module while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and automatic procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

Part 2. Remove the Column

2-1. Remove the column as described in Parts 1, 2, 3, and 4 of Service Procedure 05-09-05, Column Removal and Replacement: 5 nm Column. Bring the column to the work area immediately. Cover any openings in the workchamber with aluminum foil.

CAUTION

Use care when lifting and moving the column cap and column housing assemblies. The column gun assembly weighs approximately 25 pounds (11 kg). The column housing weighs approximately 50 pounds (28 kg). If necessary to avoid personal injury, get help.

2-2. Place the column assembly upside down on the work surface.

2-3. Note the rotational position of the lower shield. **The lower shield must be reinstalled in its original position for proper MCP alignment**. Remove the lower shield by loosening the three Phillips-head screws (see Figure 1).

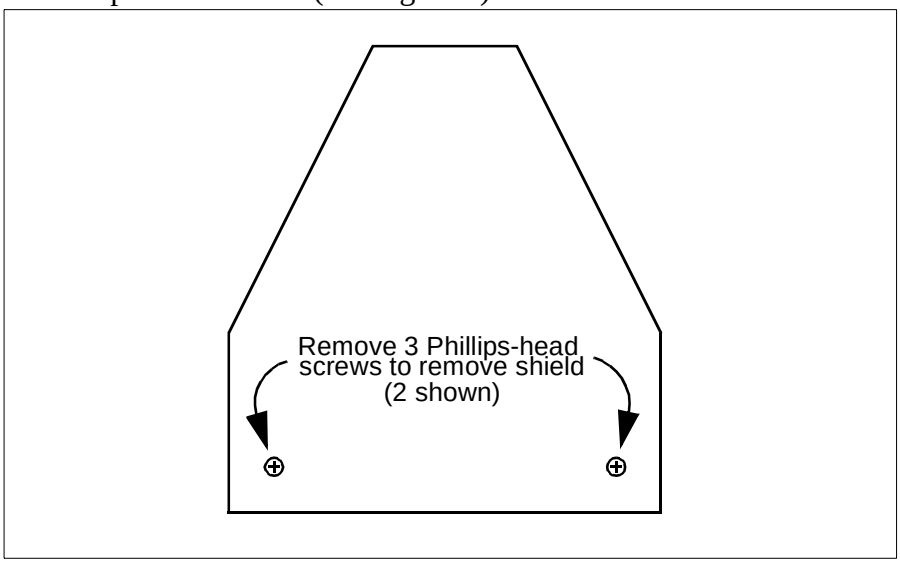


Figure 1. Side and Bottom Views of Lower Shield with Mounting Screws

WEAR GLOVES, DO NOT HANDLE SOLVENTS

When working inside the chamber or when handling any components that will be exposed to vacuum, wear gloves rated for Class 100 environments or better. Due to disintegration of such gloves by solvents and the possibility of contaminating parts, do not handle solvents or parts that are wet with solvent.

NOTICE: LOWER COLUMN ELEMENTS ARE FRAGILE

Handle the lower column and its elements with great care. Any scratches will ruin the lower column (Lens 2) elements. Also, any metal tracks left on ceramic surfaces cause serious problems with the column operation.

Part 3. Column Cleaning

3-1. Under high intensity light, examine the column for contaminants.

NOTE: The high-intensity light must shine across the surface of interest at a shallow angle. Otherwise you will illuminate everything evenly, making particle detection difficult.

The exposed lower column (Lens 2) will be upside down on the workbench. Figure 2 shows the lower column elements.

3-2. Use the lens brush, cotton tipped applicators, and nitrogen to gently clean off any contaminants you find. Clean the rest of the column throughly, including the ion gun.

3-3. Clean the interior of the lower shield.

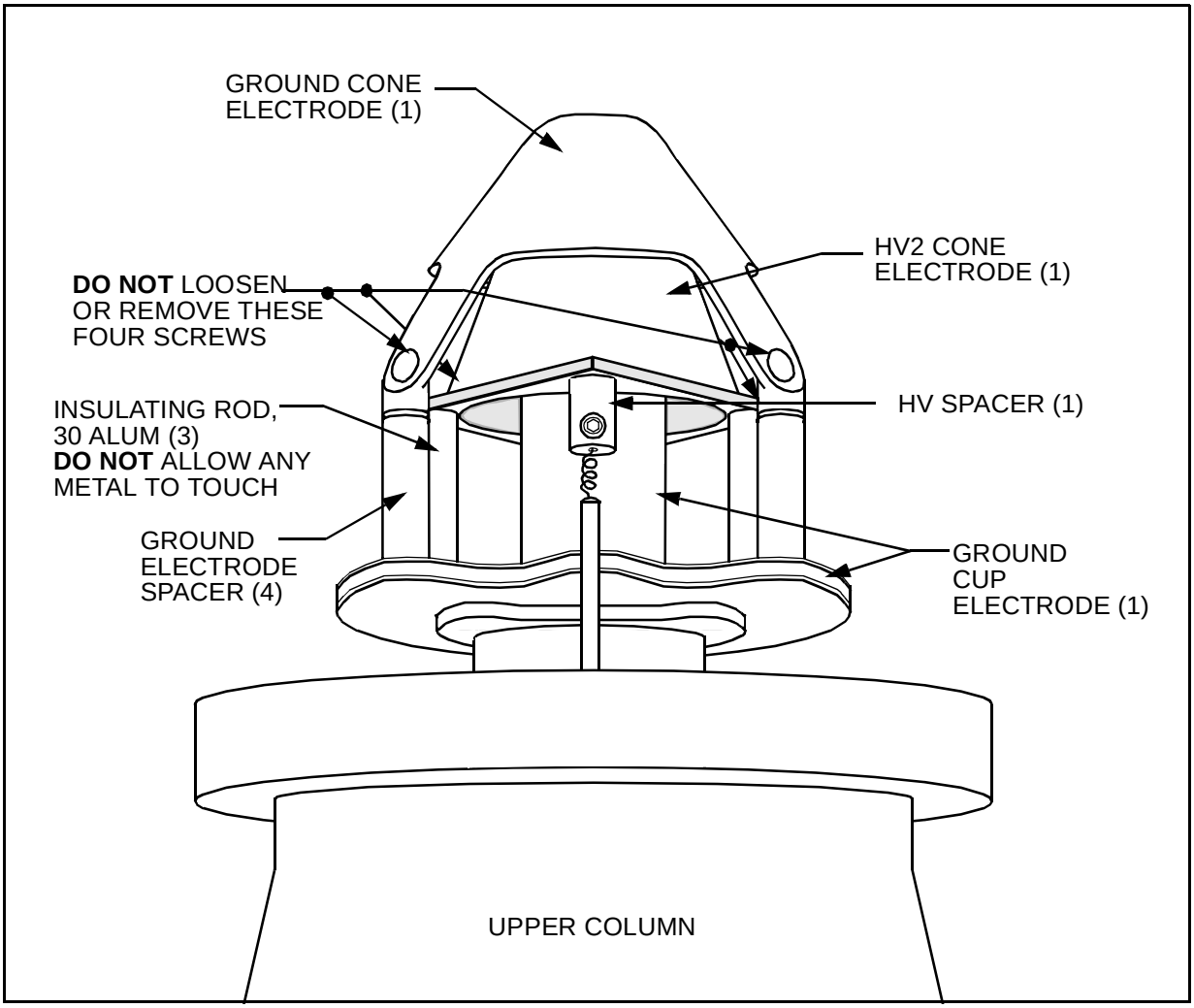

GROUND CONE ELECTRODE (1)
HV2 CONE ELECTRODE (1)
DO NOT LOOSEN OR REMOVE THESE FOUR SCREWS
HV SPACER (1)
INSULATING ROD, 30 ALUM (3) **DO NOT** ALLOW ANY METAL TO TOUCH
GROUND ELECTRODE SPACER (4)
GROUND CUP ELECTRODE (1)
UPPER COLUMN

Figure 2. Lower Column (Lens 2) Without Shield

3-4. Reinstall the lower shield in its original rotational position. The center bores of the lower shield and the Lens 2 assembly should be concentric (centrally aligned).

3-5. Clean the workchamber (as described in Service Procedure 06-03) and the ion pump connector tube.

3-6. Reinstall the column as described in Part 5 of Service Procedure 05-09-05, Column Removal and Replacement: 5 nm Column.

Micrion

Service Procedure No.: **05-02-10**
Service Procedure Title: **Cleaning the Lower Column (Lens 2) Elements: 10 nm Column**
Applicable Systems: **8000, Micrion 9800 FlipChip, MicroMill HT Systems**
Frequency of Service: **As Needed**

Introduction

When the workchamber is vented the column elements may become contaminated. For the system to maintain optimal performance, the column elements must be free of contaminants. Be careful not to damage any part of the column during the cleaning procedure: any scratches will ruin the lower column (Lens 2) elements, and any metal tracks left on ceramic surfaces cause serious problems with the column operation. Clean the column elements only if you are reasonably certain that they have become contaminated.

Required Materials

This procedure requires the following materials:

- Clean room, preferably with a class 100 airflow hood; however, a properly cleaned and prepared work area will be sufficient
- Clean, standard field service tools (completely free of oil and grease)
- Lint-free wipes
- Clean-room gloves
- High intensity light source
- Aluminum foil
- Clean lens brush
- Clean, filtered dry nitrogen (an ionizing N_2 gun with at least 20 psi is preferred)
- Cotton-tipped applicators

NOTICE

Per paragraph 11.1 of *Safety Guidelines for Semiconductor Manufacturing Equipment* (S2-93), this procedure is a Type 3 task: “Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are less than 30 volts RMS, 42.2 volts peak, 240 volt-amps, and 20 Joules.”

NOTICE: TRAINING IS REQUIRED FOR THIS PROCEDURE

Do not attempt to perform this procedure unless you have been properly trained. Only qualified personnel should perform this procedure.

Part1. System Preparation

Configure the Chemical Sources in "Safe" Mode

Before performing the tasks described in this procedure, you must put the chemical sources in a "safe" mode; see Service Procedure 02-01.

WARNING

Do not proceed until the chemical sources are secure. The chemical reservoirs in FIB systems contain hazardous materials. Labels affixed to the exterior of a chemical cabinet identify the chemical(s) contained inside. If a chemical source is not in its "safest" state, as described in **Service Procedure 02-01**, it is possible for a combination of component failures to release the chemical(s) through a cabinet's delivery line, a roughing line, a purging line, or from a chemical reservoir into the workchamber. Do not open the workchamber, or disassemble any part of the vacuum pumping system, or detach any gas line from any chemical cabinet until you are sure that every chemical source attached to the FIB system is in its "safest" state.

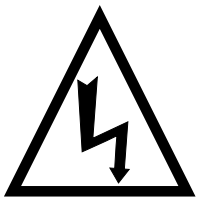
NOTICE: CLEAN THE SURROUNDING AREA

Before you vent the system, clean the exterior of the process module and surrounding area. The column is very sensitive to contamination.

Power Down and Vent the System

Before performing the tasks described in this procedure, you must power down and vent the system; see Service Procedure 01-02.

WARNING



Dangerously high voltages are present in the process module while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and automatic procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

Part 2. Remove the Column

2-1. Remove the column as described in Parts 1, 2, 3, and 4 of Service Procedure 05-09-10, Column Removal and Replacement: 10 nm Column. Bring the column to the work area immediately. Cover any openings in the workchamber with aluminum foil.

CAUTION

Use care when lifting and moving the column cap and column housing assemblies. The column gun assembly weighs approximately 25 pounds (11 kg). The column housing weighs approximately 50 pounds (28 kg). If necessary to avoid personal injury, secure the help of another person.

2-2. Place the column assembly upside down on the work surface.

2-3. Note the rotational position of the lower shield. **The lower shield must be reinstalled in its original position for proper MCP alignment**. Remove the lower shield by loosening the three Phillips-head screws (see Figure 1).

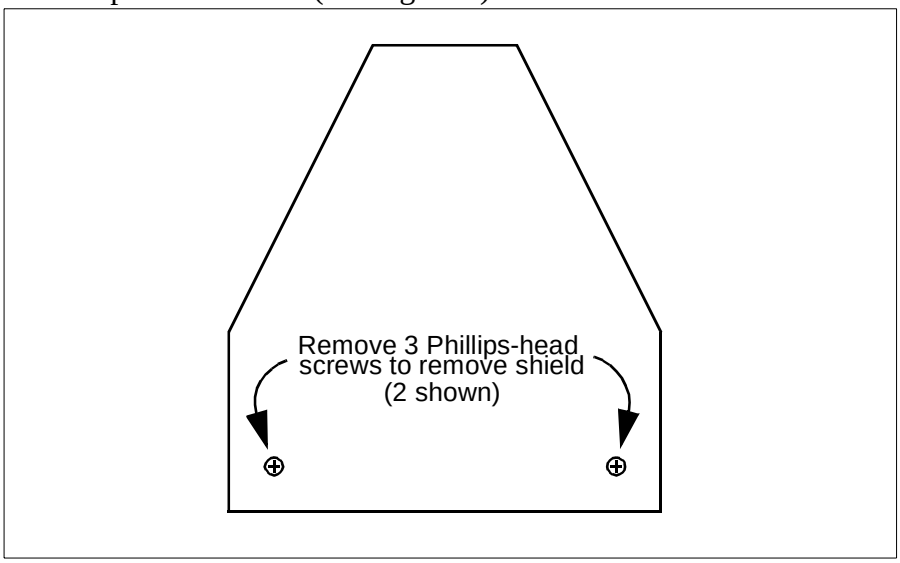


Figure 1. Side and Bottom Views of Lower Shield with Mounting Screws

WEAR GLOVES, DO NOT HANDLE SOLVENTS

When working inside the chamber or when handling any components that will be exposed to vacuum, wear gloves rated for Class 100 environments or better. Due to disintegration of such gloves by solvents and the possibility of contaminating parts, do not handle solvents or parts that are wet with solvent.

NOTICE: LOWER COLUMN ELEMENTS ARE FRAGILE

Handle the lower column and its elements with great care. Any scratches will ruin the lower column (Lens 2) elements. Also, any metal tracks left on ceramic surfaces cause serious problems with the column operation.

Part 3. Column Cleaning

3-1. Under high intensity light, examine the column for contaminants.

NOTE: The high-intensity light must shine across the surface of interest at a shallow angle. Otherwise you will illuminate everything evenly, making particle detection difficult.

The exposed lower column (Lens 2) will be upside down on the workbench. Figure 2 shows the lower column elements.

3-2. Use the lens brush, cotton tipped applicators, and nitrogen to gently clean off any contaminants you find. Clean the rest of the column throughly, including the ion gun.

3-3. Clean the interior of the lower shield.

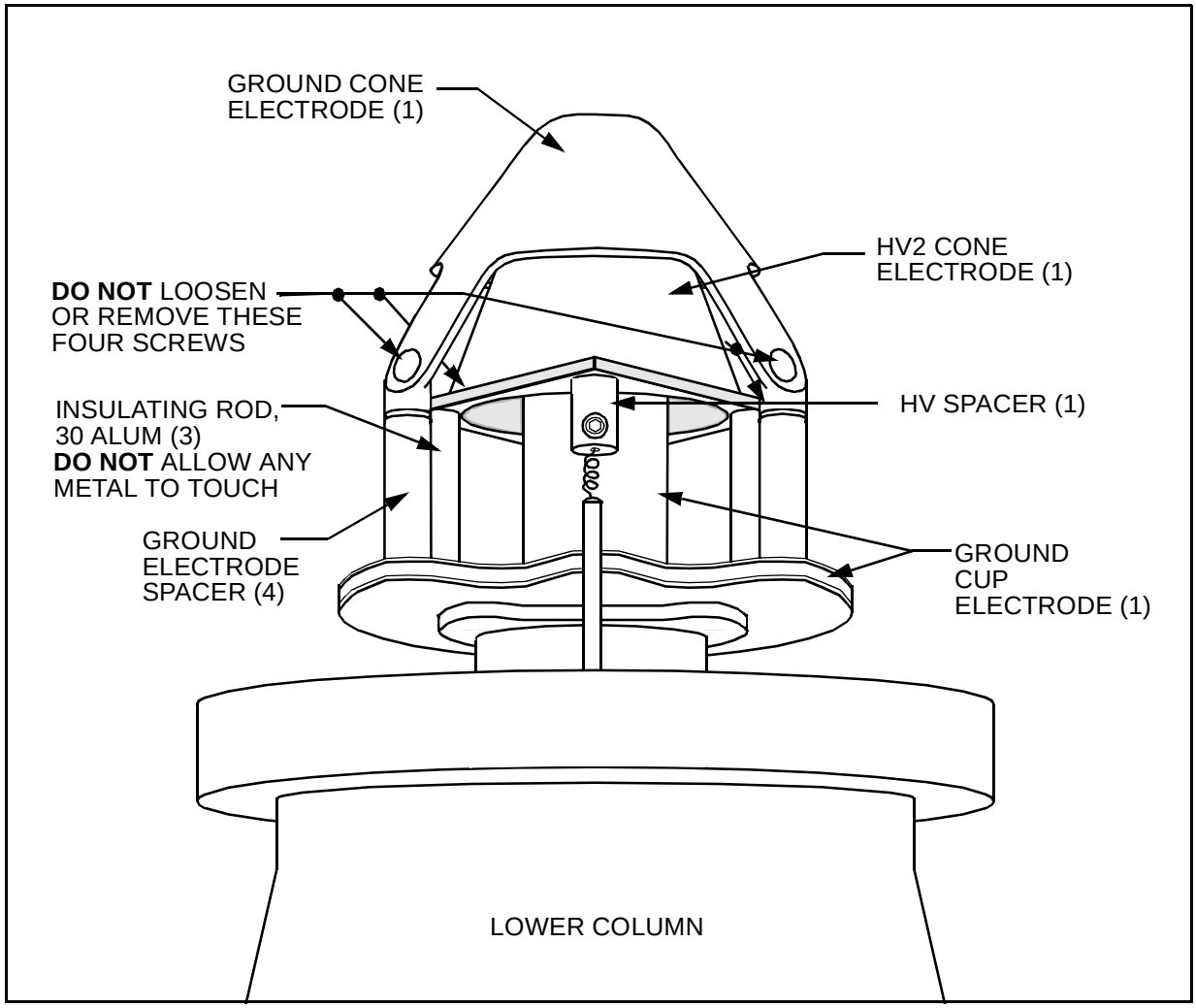

GROUND CONE ELECTRODE (1)
HV2 CONE ELECTRODE (1)
DO NOT LOOSEN OR REMOVE THESE FOUR SCREWS
HV SPACER (1)
INSULATING ROD, 30 ALUM (3) **DO NOT** ALLOW ANY METAL TO TOUCH
GROUND ELECTRODE SPACER (4)
GROUND CUP ELECTRODE (1)
LOWER COLUMN

Figure 2. Lower Column (Lens 2) Without Shield

3-4. Reinstall the lower shield in its original rotational position. The center bores of the lower shield and the Lens 2 assembly should be concentric (centrally aligned).

3-5. Clean the workchamber (as described in Service Procedure 06-03) and the ion pump connector tube.

3-6. Reinstall the column as described in Part 5 of Service Procedure 05-09-10, Column Removal and Replacement: 10 nm Column.

Micrion

Service Procedure No.: **05-02-25**
Service Procedure Title: **Cleaning the Lower Column (Lens 2) Elements: 25 nm Column**
Applicable Systems: **8000, Micrion 9800 FlipChip, MicroMill HT Systems**
Frequency of Service: **As Needed**

Introduction

When the workchamber is vented the column elements may become contaminated. For the system to maintain optimal performance, the column elements must be free of contaminants. Be careful not to damage any part of the column during the cleaning procedure: any scratches will ruin the lower column (Lens 2) elements, and any metal tracks left on ceramic surfaces cause serious problems with the column operation. Clean the column elements only if you are reasonably certain that they have become contaminated.

Required Materials

This procedure requires the following materials:

- Clean room, preferably with a class 100 airflow hood; however, a properly cleaned and prepared work area will be sufficient
- Clean, standard field service tools (completely free of oil and grease)
- Lint-free wipes
- Clean-room gloves
- High intensity light source
- Aluminum foil
- Clean lens brush
- Clean, filtered dry nitrogen (an ionizing N_2 gun with at least 20 psi is preferred)
- Cotton-tipped applicators

NOTICE

Per paragraph 11.1 of *Safety Guidelines for Semiconductor Manufacturing Equipment* (S2-93), this procedure is a Type 3 task: “Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are less than 30 volts RMS, 42.2 volts peak, 240 volt-amps, and 20 Joules.”

NOTICE: TRAINING IS REQUIRED FOR THIS PROCEDURE

Do not attempt to perform this procedure unless you have been properly trained. Only qualified personnel should perform this procedure.

Part1. System Preparation

Configure the Chemical Sources in "Safe" Mode

Before performing the tasks described in this procedure, you must put the chemical sources in a "safe" mode; see Service Procedure 02-01.

WARNING

Do not proceed until the chemical sources are secure. The chemical reservoirs in FIB systems contain hazardous materials. Labels affixed to the exterior of a chemical cabinet identify the chemical(s) contained inside. If a chemical source is not in its "safest" state, as described in **Service Procedure 02-01**, it is possible for a combination of component failures to release the chemical(s) through a cabinet's delivery line, a roughing line, a purging line, or from a chemical reservoir into the workchamber. Do not open the workchamber, or disassemble any part of the vacuum pumping system, or detach any gas line from any chemical cabinet until you are sure that every chemical source attached to the FIB system is in its "safest" state.

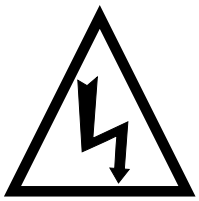
NOTICE: CLEAN THE SURROUNDING AREA

Before you vent the system, clean the exterior of the process module and surrounding area. The column is very sensitive to contamination.

Power Down and Vent the System

Before performing the tasks described in this procedure, you must power down and vent the system; see Service Procedure 01-02.

WARNING



Dangerously high voltages are present in the process module while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and automatic procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

Part 2. Remove the Column

2-1. Remove the column as described in Parts 1, 2, 3, and 4 of Service Procedure 05-09-25, Column Removal and Replacement: 25 nm Column. Bring the column to the work area immediately. Cover any openings in the workchamber with aluminum foil.

CAUTION

Use care when lifting and moving the column cap and column housing assemblies. The column cap assembly weighs approximately 25 pounds (11 kg). The column housing weighs approximately 50 pounds (28 kg). If necessary to avoid personal injury, secure the help of another person.

2-2. Place the column assembly upside down on the work surface.

2-3. Note the rotational position of the lower shield. **The lower shield must be reinstalled in its original position for proper MCP alignment**. Remove the lower shield by loosening the three Phillips-head screws (see Figure 1).

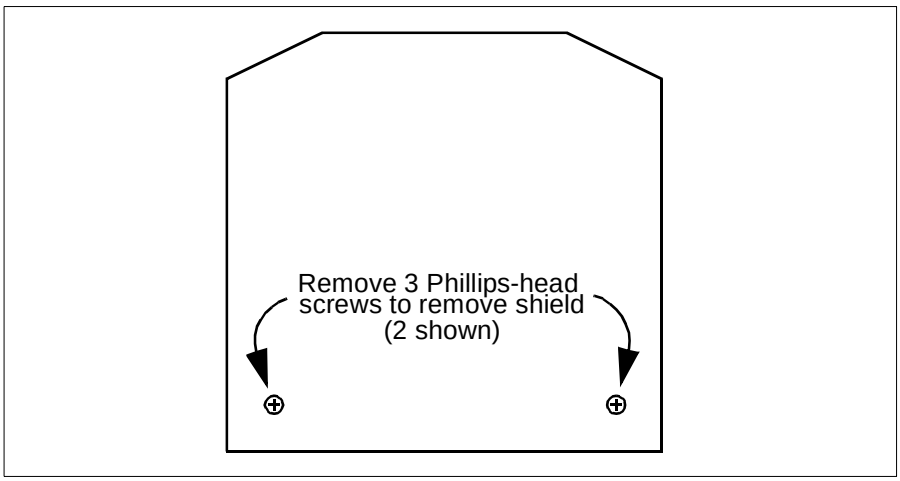


Figure 1. Side and Bottom Views of Lower Shield with Mounting Screws

WEAR GLOVES, DO NOT HANDLE SOLVENTS

When working inside the chamber or when handling any components that will be exposed to vacuum, wear gloves rated for Class 100 environments or better. Due to disintegration of such gloves by solvents, do not handle solvents or parts that are wet with solvent.

NOTICE: LOWER COLUMN ELEMENTS ARE FRAGILE

Handle the lower column and its elements with great care. Any scratches will ruin the lower column (Lens 2) elements. Also, any metal tracks left on ceramic surfaces cause serious problems with the column operation.

Part 3. Column Cleaning

3-1. Under high intensity light, examine the column for contaminants.

NOTE: The high-intensity light must shine across the surface of interest at a shallow angle. Otherwise you will illuminate everything evenly, making particle detection difficult.

The exposed lower column (Lens 2) will be upside down on the workbench. Figure 2 shows the lower column elements.

3-2. Use the lens brush, cotton tipped applicators, and nitrogen to gently clean off any contaminants you find. Negative element surfaces are especially susceptible to particulate contamination. Clean the rest of the column throughly, including the ion gun.

3-3. Clean the interior of the lower shield.

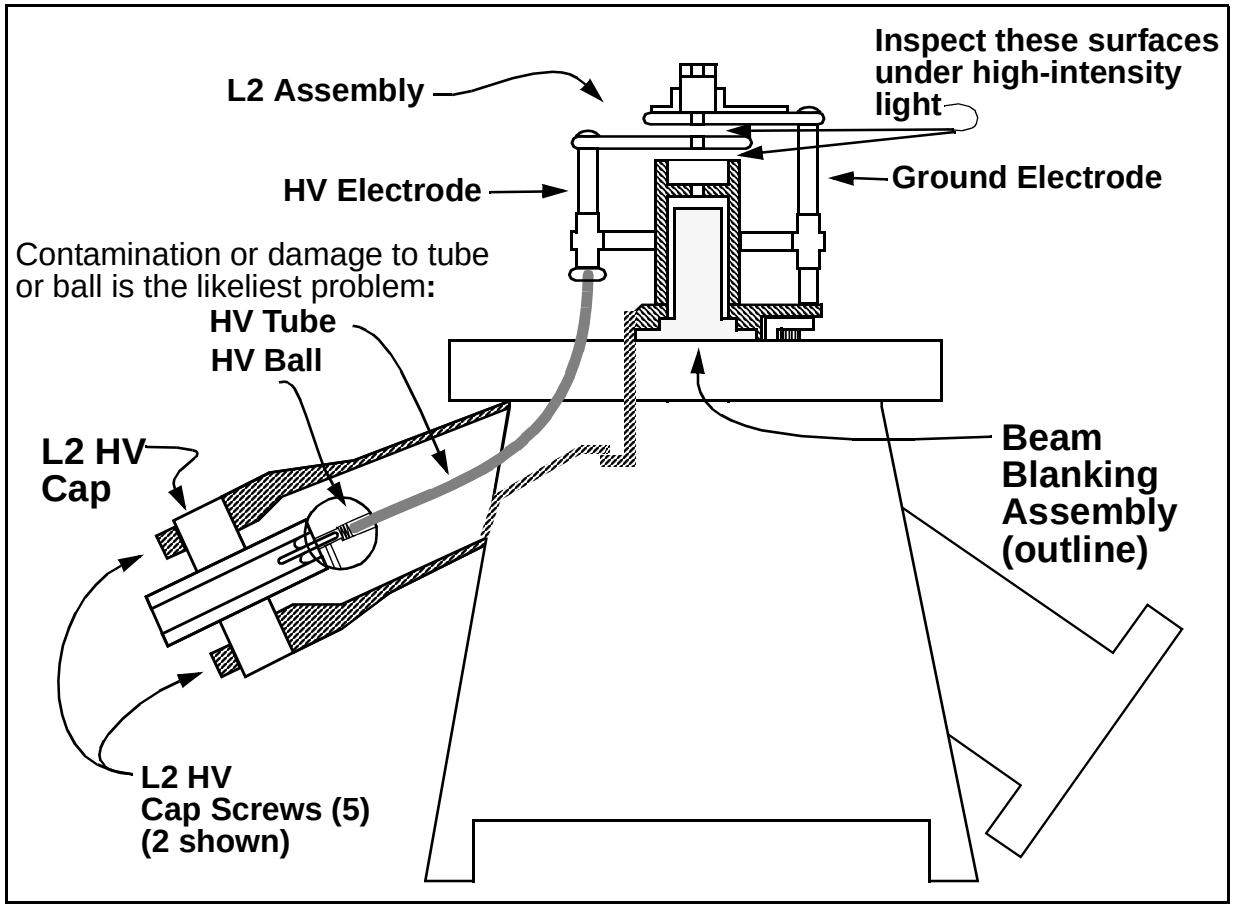

L2 Assembly
Inspect these surfaces under high-intensity light
HV Electrode
Ground Electrode
Contamination or damage to tube or ball is the likeliest problem:
HV Tube
HV Ball
L2 HV Cap
Beam Blanking Assembly (outline)
L2 HV Cap Screws (5) (2 shown)

Figure 2. Lower Column (Lens 2) Without Shield

3-4. Reinstall the lower shield **in its original rotational position**. The center bores of the lower shield and the Lens 2 assembly should be concentric (centrally aligned).

3-5. Clean the workchamber (as described in Service Procedure 06-03) and the ion pump connector tube.

3-6. Reinstall the column as described in Part 5 of Service Procedure 05-09-25, Column Removal and Replacement: 25 nm Column.

Micrion

Service Procedure No.: **05-03-05**
Service Procedure Title: **MCP Removal and Replacement: 5 nm Column**
Applicable Systems: **8000, Micrion 9800 FlipChip, MicroMill HT**
Frequency of Service: **As needed.**

Introduction

This procedure describes the removal of the microchannel plate (MCP) from the column of the FIB system, and the installation of a replacement MCP.

Materials Required

This procedure requires the use of the following materials:

- Clean, standard field service kit
- Lint-free wipes
- Clean-room gloves
- Laboratory-grade isopropyl alcohol

NOTICE

Per paragraph 11.1 of Safety Guidelines for Semiconductor Manufacturing Equipment (S2-93), this procedure is a Type 5 task. Specifically: "Equipment is energized and measurements and adjustments require physical entry into the equipment, or equipment configuration will not allow the use of clamp-on probes."

Part 1. System Preparation

Configure the Chemical Sources in "Safe" Mode

Before performing the tasks described in this procedure, you must put the chemical sources in a "safe" mode; see Service Procedure 02-01.

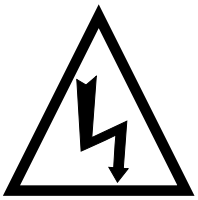
WARNING

Do not proceed until the chemical sources are secure. The chemical reservoirs in FIB systems contain hazardous materials. Labels affixed to the exterior of a chemical cabinet identify the chemical(s) contained inside. If a chemical source is not in its "safest" state, as described in **Service Procedure 02-01**, it is possible for a combination of component failures to release the chemical(s) through a cabinet's delivery line, a roughing line, a purging line, or from a chemical reservoir into the workchamber. Do not open the workchamber, or disassemble any part of the vacuum pumping system, or detach any gas line from any chemical cabinet until you are sure that every chemical source attached to the FIB system is in its "safest" state.

Power Down and Vent the System

Before performing the tasks described in this procedure, you must power down and vent the system; see Service Procedure 01-02.

WARNING



Dangerously high voltages are present in the process module while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and automatic procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

Clean off the exterior of the system as well as the floor; see Service Procedure 06-05.

Open the Workchamber

Remove the front panels to gain access to the workchamber door.

Once the system is completely vented, open the workchamber door by removing the 1/2" socket head cap screws.

WEAR GLOVES, DO NOT HANDLE SOLVENTS

When working inside the chamber or when handling any components that will be exposed to vacuum, wear gloves rated for Class 100 environments or better. Due to disintegration of such gloves by solvents, do not handle solvents or parts that are wet with solvent.

Part 2. Removing the MCP

2-1. After the system has vented, open the workchamber. Two types of flood gun/MCP configurations are installed in FIB systems with 5 nm columns: a flood gun without a snout combined with a small MCP[1] (as shown in Figures 1 and 2), and a flood gun with a snout paired with a large MCP[2] (as shown in Figures 3, 4, and 5).

2-2. Wearing clean room gloves, loosen the flood gun height positioning screw (see Figures 6 and 7) and slide the flood gun assembly down to provide access to the MCP.

2-3. Remove the MCP electrical connectors (see Figures 6 and 7).

NOTICE: DO NOT DROP MOUNTING SCREWS OR SPACERS

Before removing and replacing the MCP, place a clean lint-free wipe below the MCP to prevent the mounting screws (and spacers, if applicable) from falling into the turbo pump or the stage hardware. **If a screw or spacer is dropped into the workchamber, be sure to retrieve it before proceeding.**

2-4. Remove the MCP from the bottom of the column by removing the mounting screws (and spacers, if applicable). See Figures 6 and 7. Be careful not to damage the MCP screen.

Note: to eliminate the risk of dropped hardware, remove the column (as described in Service Procedure 05-09-05), replace the MCP, and then reinstall the column.

[1] There are two styles of small MCP: flat and angled (see Figure 2). Both styles have the same fasteners and electrical connectors.

[2] There are two configurations of the flood gun with a snout and large MCP combination (see Figures 3 and 4). In a 9800 series system (as shown in Figure 4), the flood gun is rotated 90° to accommodate the installation of an optical microscope.

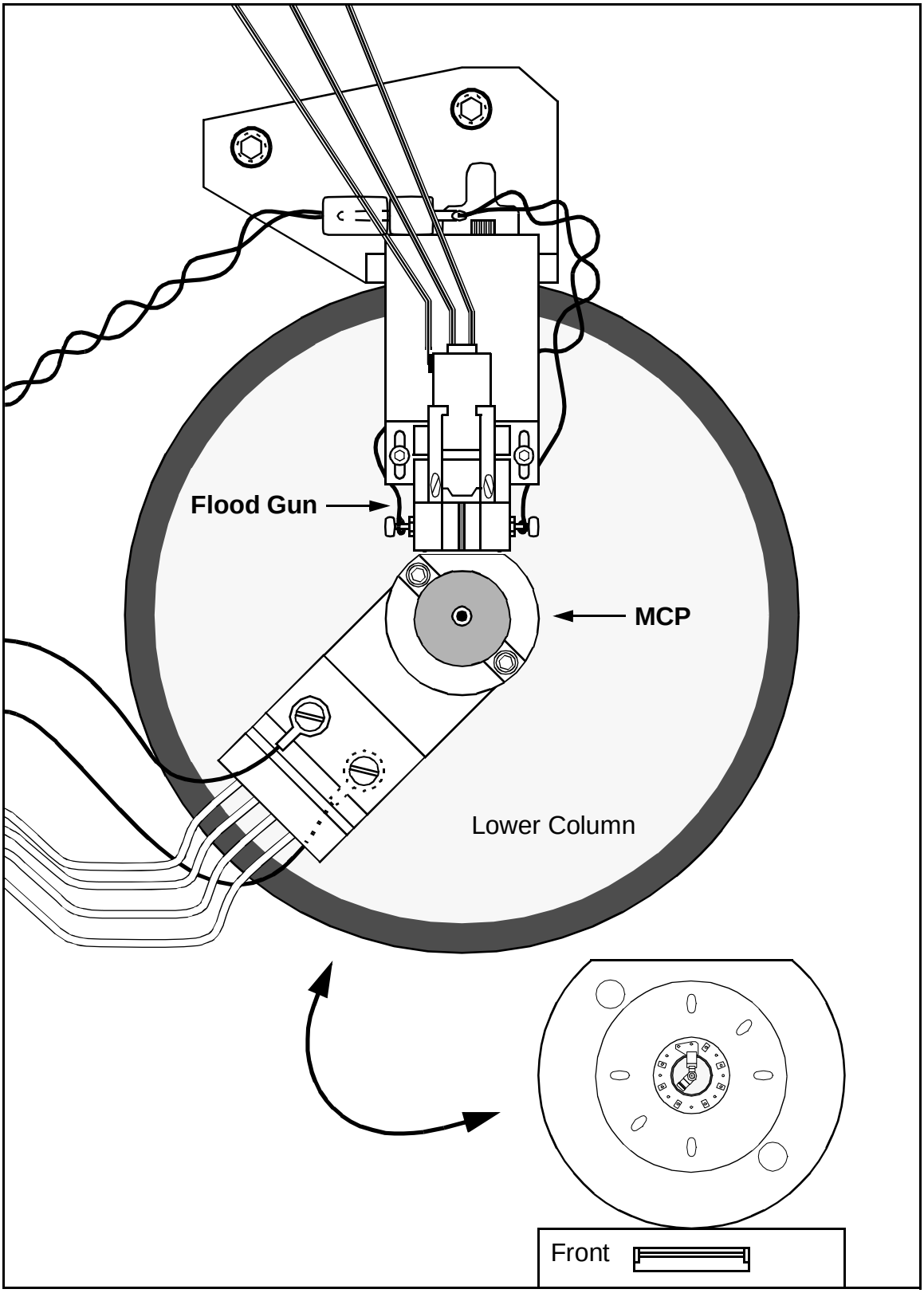


Figure 1. Flood Gun Without Snout and Small MCP: Interior View

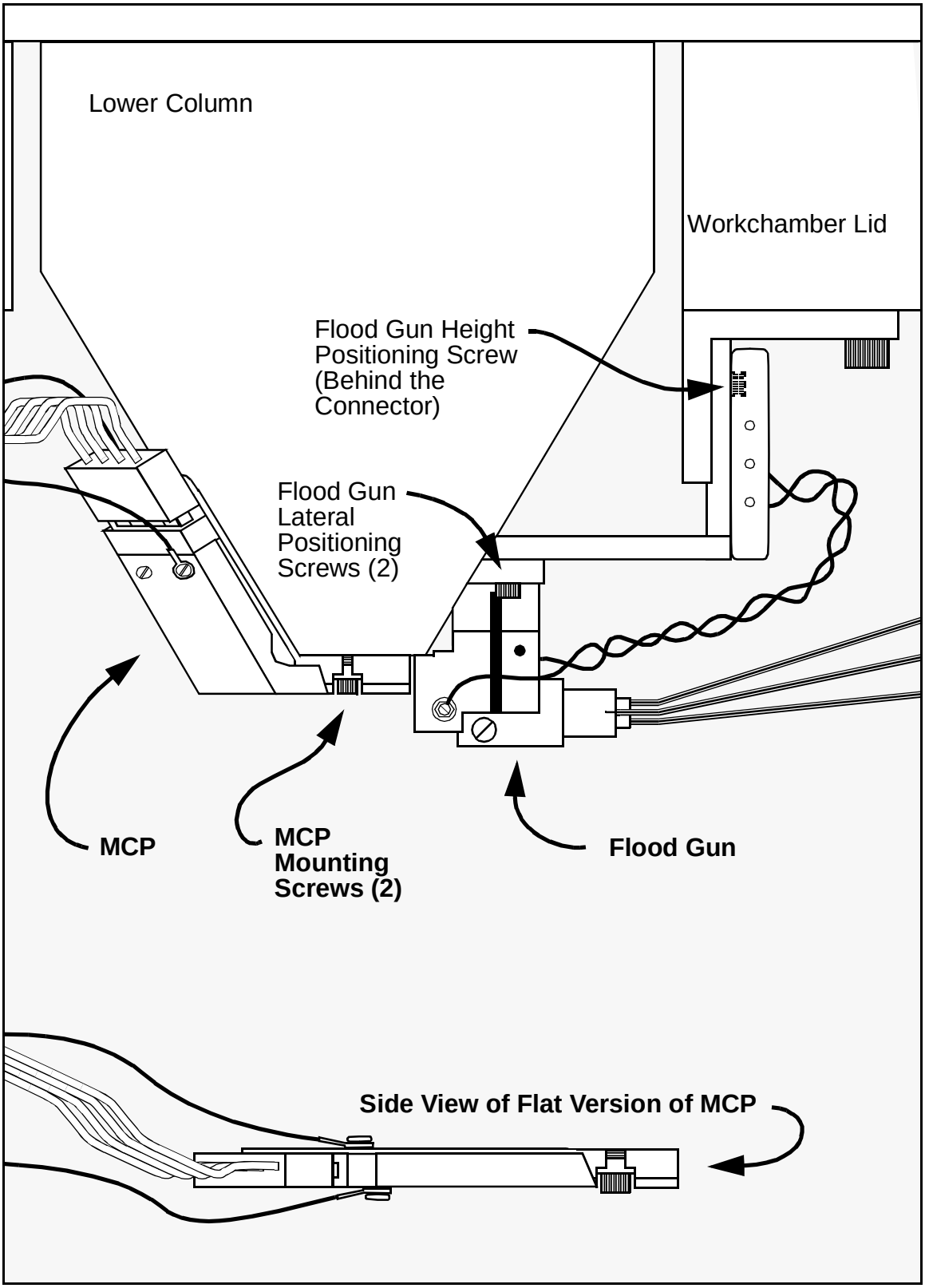

Lower Column
Workchamber Lid
Flood Gun Height Positioning Screw (Behind the Connector)
Flood Gun Lateral Positioning Screws (2)
MCP
MCP Mounting Screws (2)
Flood Gun
Side View of Flat Version of MCP

Figure 2. Side View of Flood Gun Without Snout and Small MCP(s)

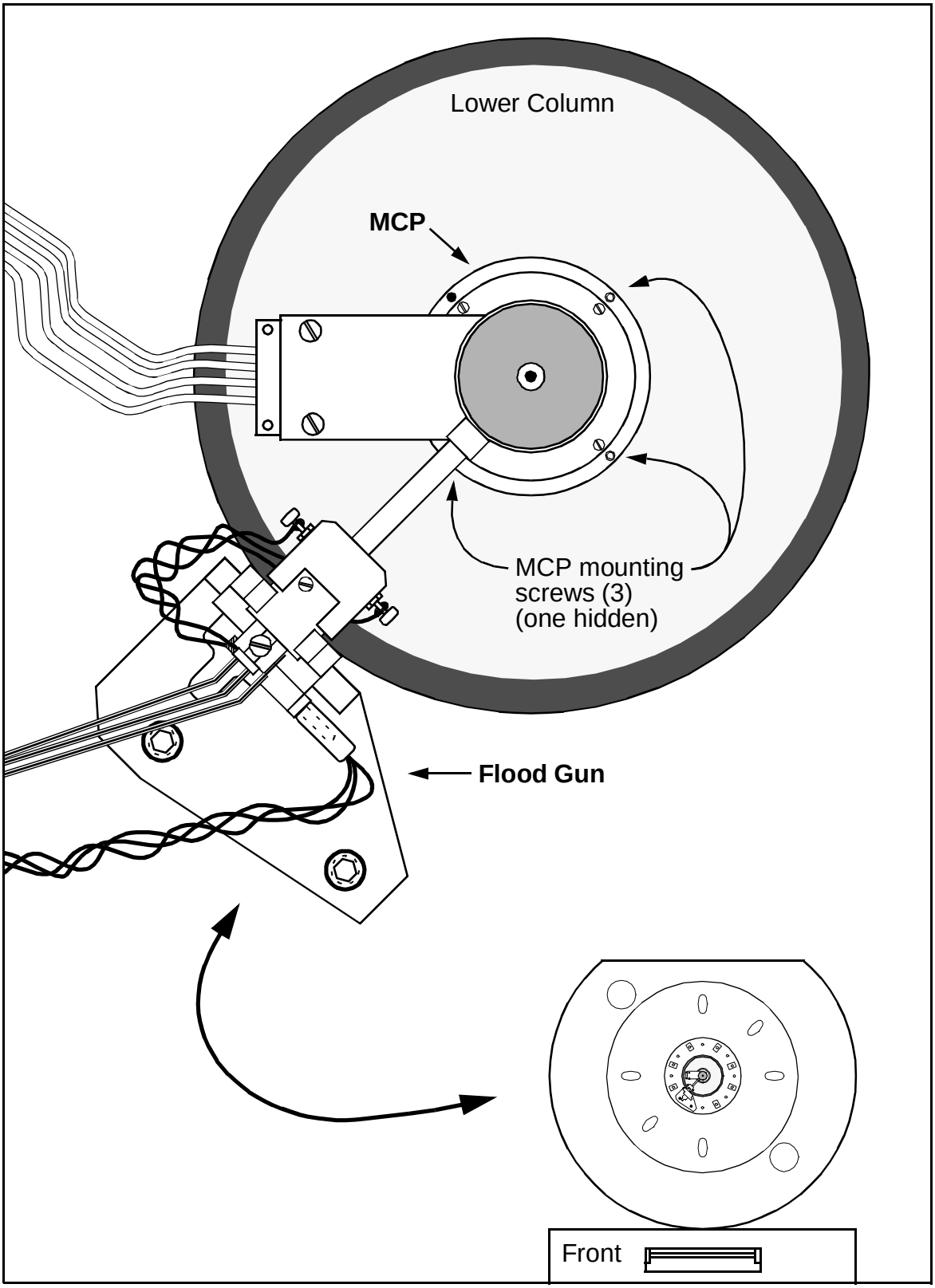


Figure 3. Flood Gun With Snout and Large MCP: Interior View

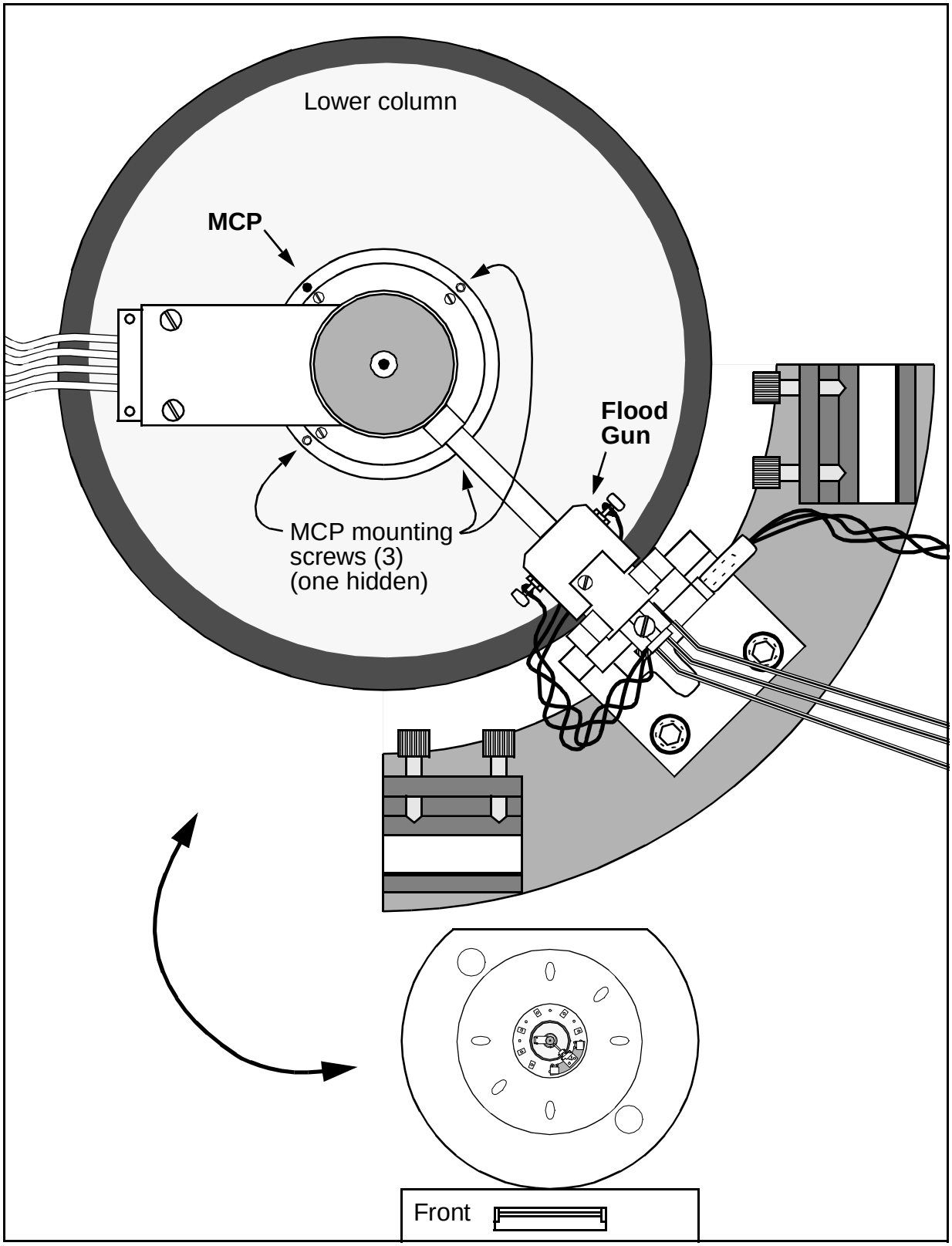


Figure 4. Flood Gun With Snout and Large MCP in 9800 System: Interior View

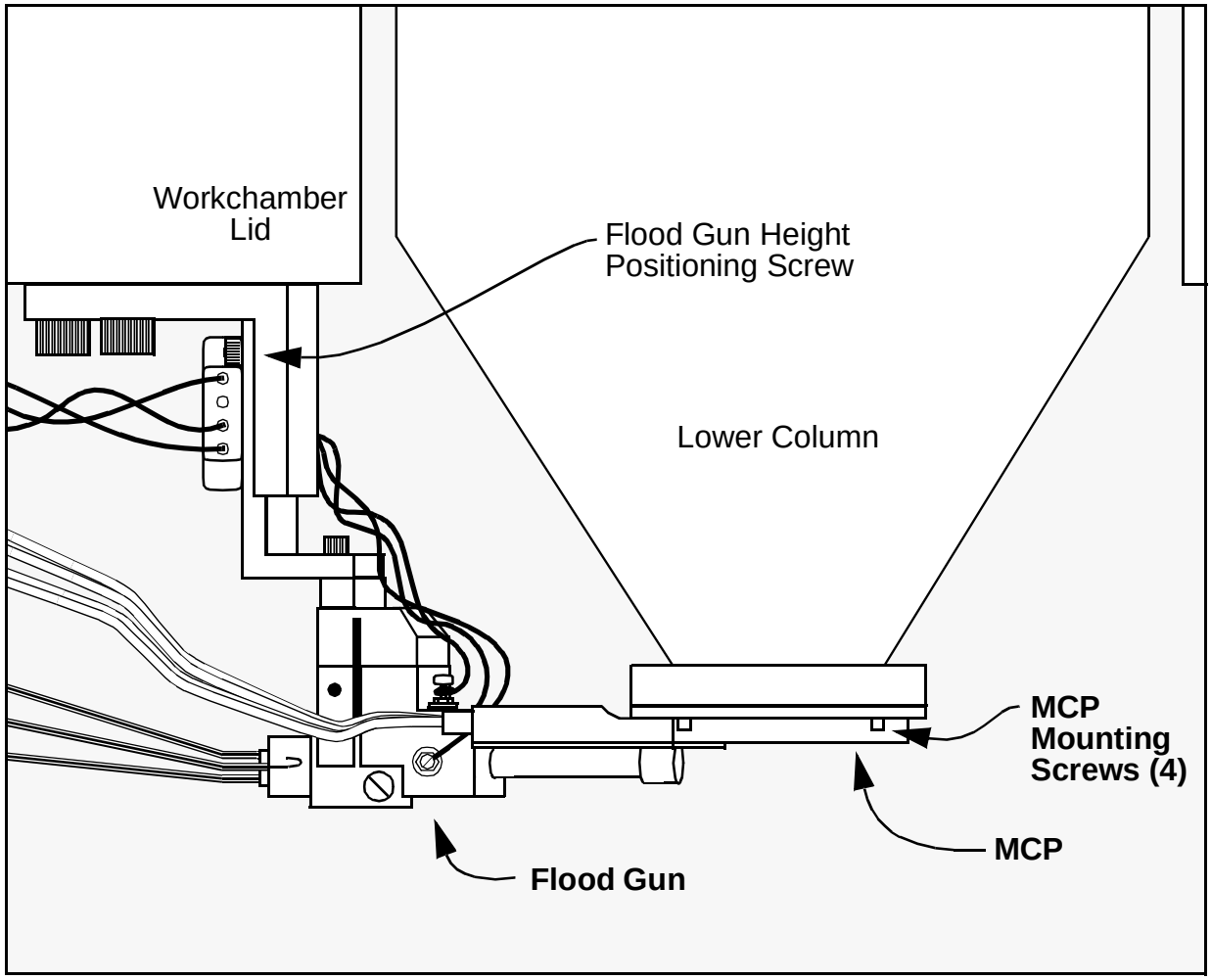


Figure 5. Side View of Flood Gun With Snout and Large MCP

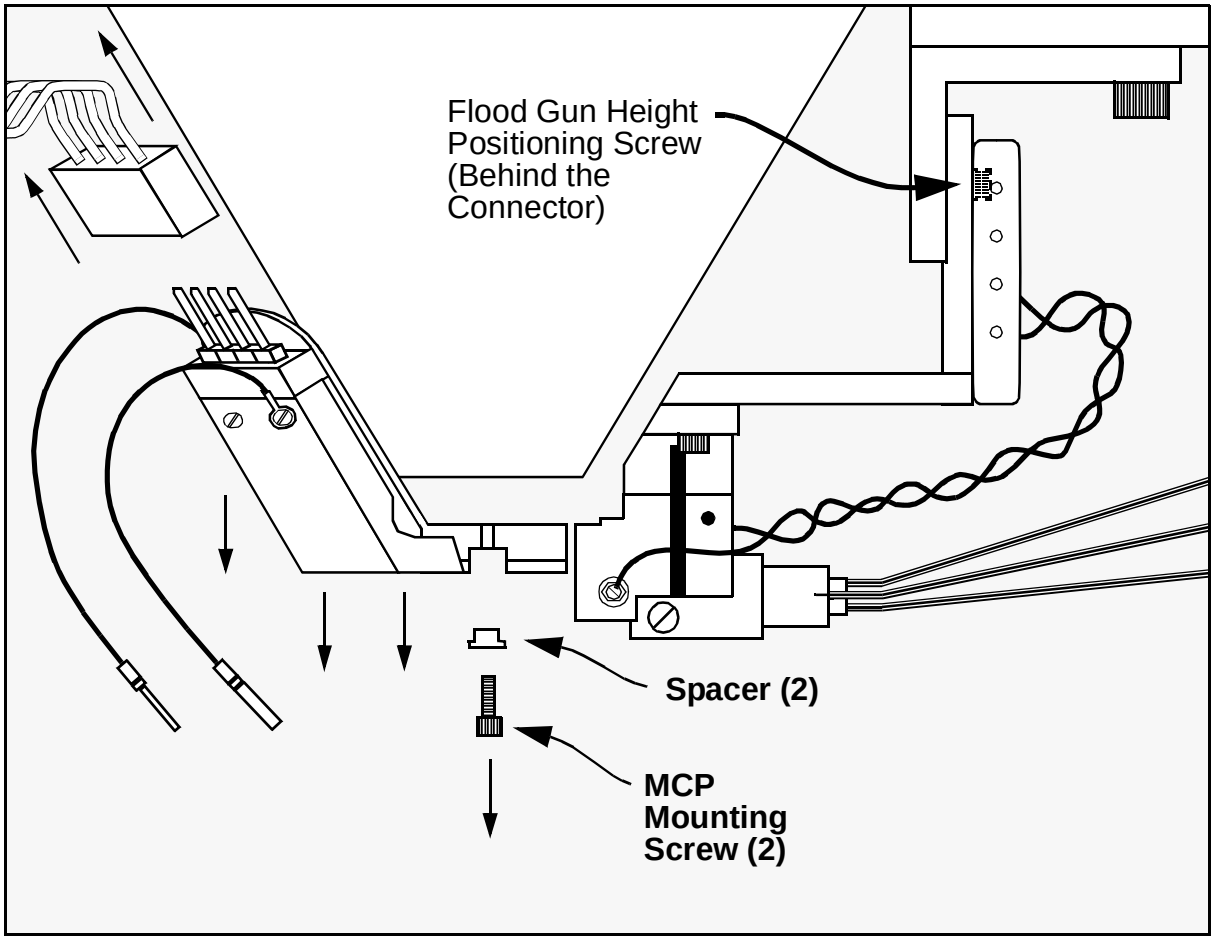


Figure 6. Side View of Flood Gun Without Snout and Small MCP: Flood Gun Lowered and MCP Disconnected.

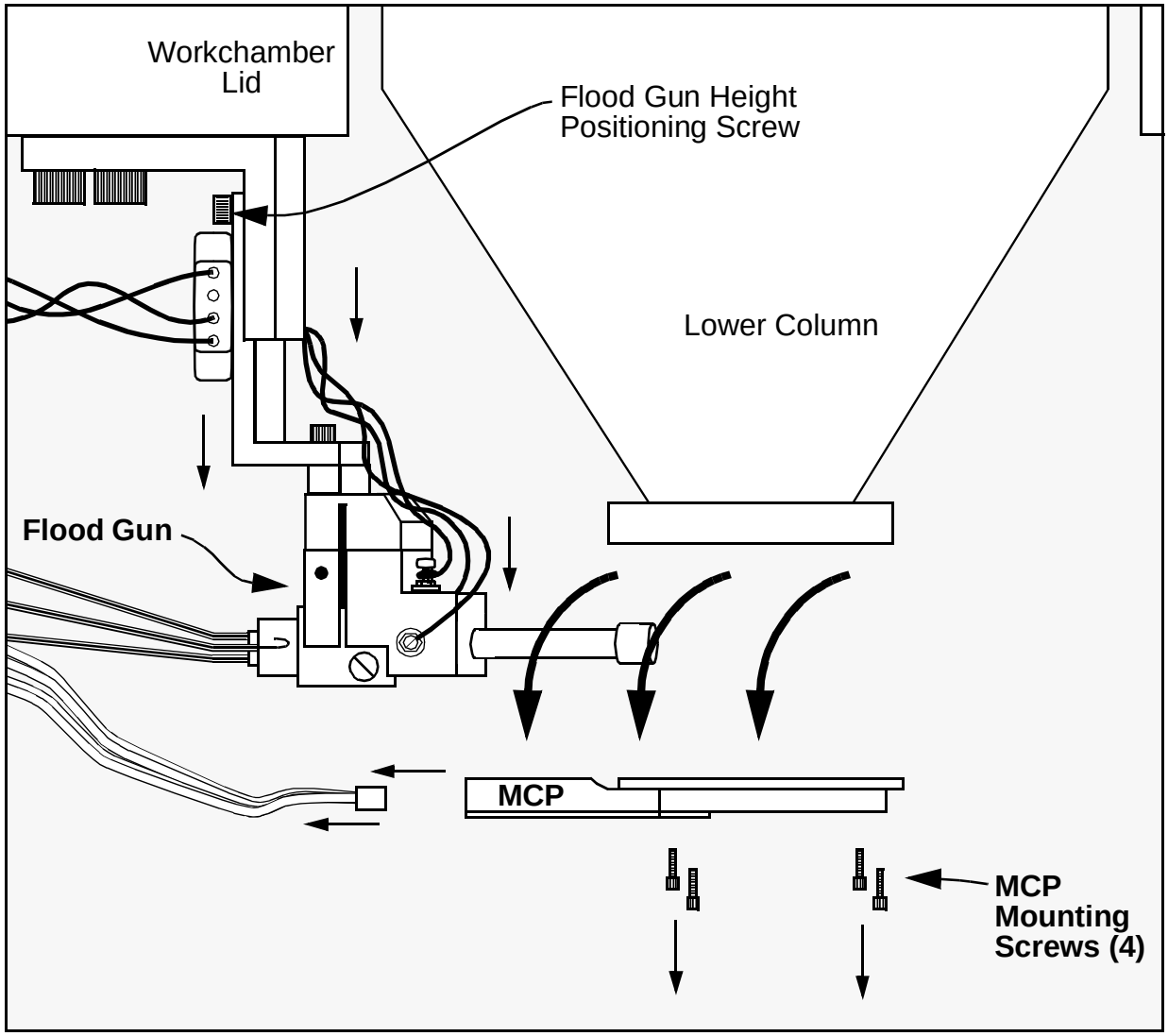


Figure 7. Side View of Flood Gun With Snout and Large MCP: Flood Gun Lowered and MCP Disconnected.

Part 3. Replacing the MCP

3-1. Fasten the replacement MCP to the bottom of the column with the MCP mounting screws (see Figures 6 and 7).

3-2. Reattach the MCP electrical connectors.

3-3. Slide the flood gun subassembly up until it contacts the lower column. Make sure that the flood gun is aligned with (points directly at) the center bore of the MCP (see Figures 1, 2, 3, 4, and 5). Tighten the flood gun height positioning screw (see Figures 2 and 5).

3-4. Clean the workchamber (see Service Procedure 06-03), then close the workchamber door.

3-5. Power up the system as described in Service Procedure 01-01, and pump down the system as described in Service Procedure 04-03.

Micrion

Service Procedure No.: **05-03-10**
Service Procedure Title: **MCP Removal and Replacement: 10 nm Column**
Applicable Systems: **8000, Micrion 9800 FlipChip, MicroMill HT**
Frequency of Service: **As needed.**

Introduction

This procedure describes the removal of the microchannel plate (MCP) from the column of the FIB system, and the installation of a replacement MCP.

Materials Required

This procedure requires the use of the following materials:

- Clean, standard field service kit
- Lint-free wipes
- Clean-room gloves
- Laboratory-grade isopropyl alcohol

NOTICE

Per paragraph 11.1 of Safety Guidelines for Semiconductor Manufacturing Equipment (S2-93), this procedure is a Type 5 task. Specifically: "Equipment is energized and measurements and adjustments require physical entry into the equipment, or equipment configuration will not allow the use of clamp-on probes."

Part 1. System Preparation

Configure the Chemical Sources in "Safe" Mode

Before performing the tasks described in this procedure, you must put the chemical sources in a "safe" mode; see Service Procedure 02-01.

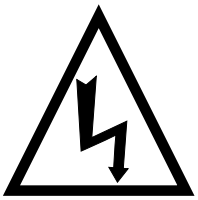
WARNING

Do not proceed until the chemical sources are secure. The chemical reservoirs in FIB systems contain hazardous materials. Labels affixed to the exterior of a chemical cabinet identify the chemical(s) contained inside. If a chemical source is not in its "safest" state, as described in **Service Procedure 02-01**, it is possible for a combination of component failures to release the chemical(s) through a cabinet's delivery line, a roughing line, a purging line, or from a chemical reservoir into the workchamber. Do not open the workchamber, or disassemble any part of the vacuum pumping system, or detach any gas line from any chemical cabinet until you are sure that every chemical source attached to the FIB system is in its "safest" state.

Power Down and Vent the System

Before performing the tasks described in this procedure, you must power down and vent the system; see Service Procedure 01-02.

WARNING



Dangerously high voltages are present in the process module while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and automatic procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

Clean off the exterior of the system as well as the floor; see Service Procedure 06-05.

Open the Workchamber

Remove the front panels to gain access to the workchamber door.

Once the system is completely vented, open the workchamber door by removing the 1/2" socket head cap screws.

WEAR GLOVES, DO NOT HANDLE SOLVENTS

When working inside the chamber or when handling any components that will be exposed to vacuum, wear gloves rated for Class 100 environments or better. Due to disintegration of such gloves by solvents, do not handle solvents or parts that are wet with solvent.

Part 2. Removing the MCP

2-1. After the system has vented, open the workchamber. Two types of flood gun/MCP configurations are installed in FIB systems with 10 nm columns: a flood gun without a snout combined with a small MCP[1] (as shown in Figures 1 and 2), and a flood gun with a snout paired with a large MCP[2] (as shown in Figures 3, 4, and 5).

2-2. Wearing clean room gloves, loosen the flood gun height positioning screw (see Figures 6 and 7) and slide the flood gun assembly down to provide access to the MCP.

2-3. Remove the MCP electrical connectors (see Figures 6 and 7).

NOTICE: DO NOT DROP MOUNTING SCREWS OR SPACERS

Before removing and replacing the MCP, place a clean lint-free wipe below the MCP to prevent the mounting screws (and spacers, if applicable) from falling into the turbo pump or the stage hardware. **If a screw or spacer is dropped into the workchamber, be sure to retrieve it before proceeding.**

2-4. Remove the MCP from the bottom of the column by removing the mounting screws (and spacers, if applicable). See Figures 6 and 7. Be careful not to damage the MCP screen.

Note: to eliminate the risk of dropped hardware, remove the column (as described in Service Procedure 05-09-10), replace the MCP, and then reinstall the column.

[1] There are two styles of small MCP: flat and angled (see Figure 2). Both styles have the same fasteners and electrical connectors.

[2] There are two configurations of the flood gun with a snout and large MCP combination (see Figures 3 and 4). In a 9800 series system (as shown in Figure 4), the flood gun is rotated 90° to accommodate the installation of an optical microscope.

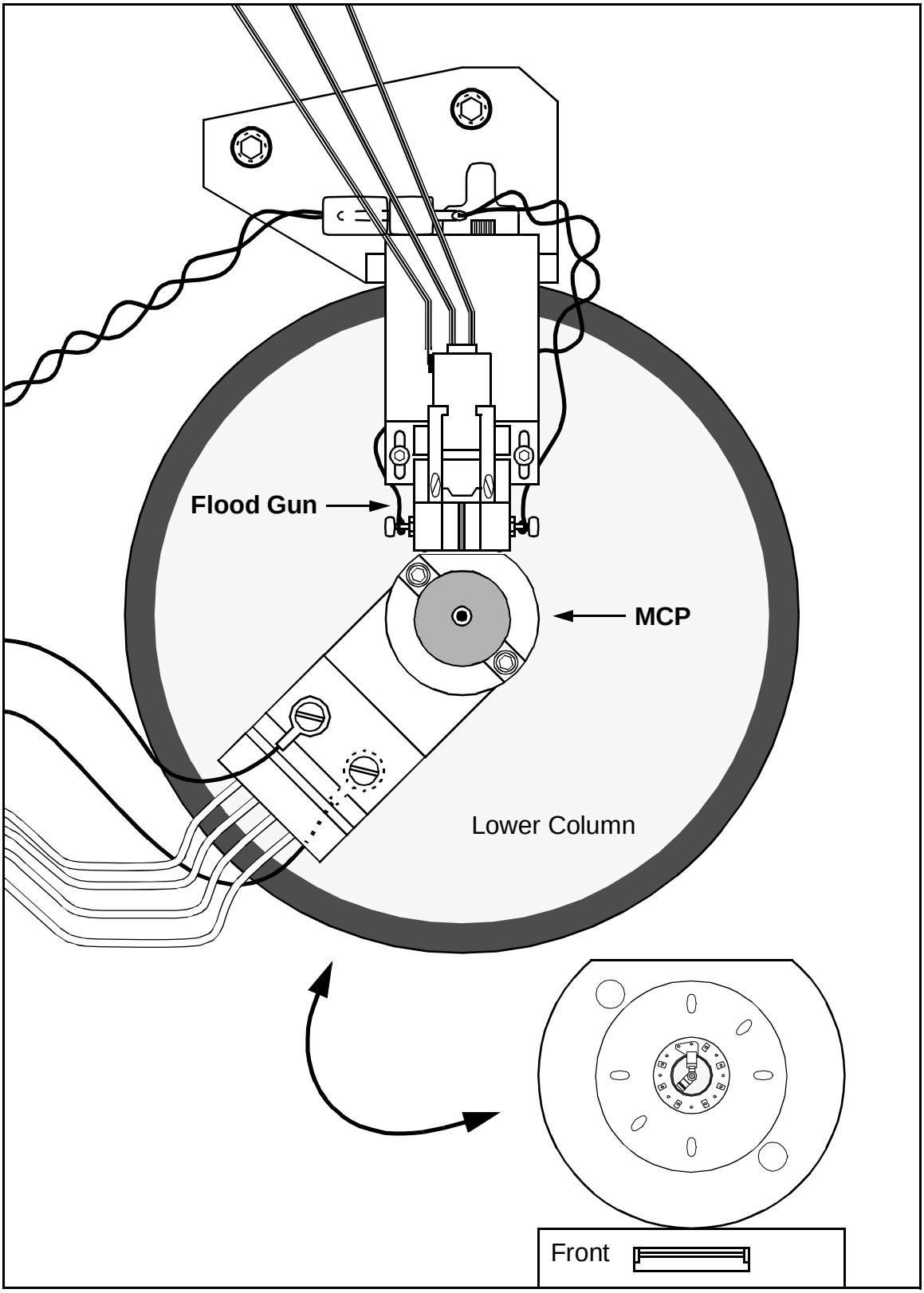


Figure 1. Flood Gun Without Snout and Small MCP: Interior View

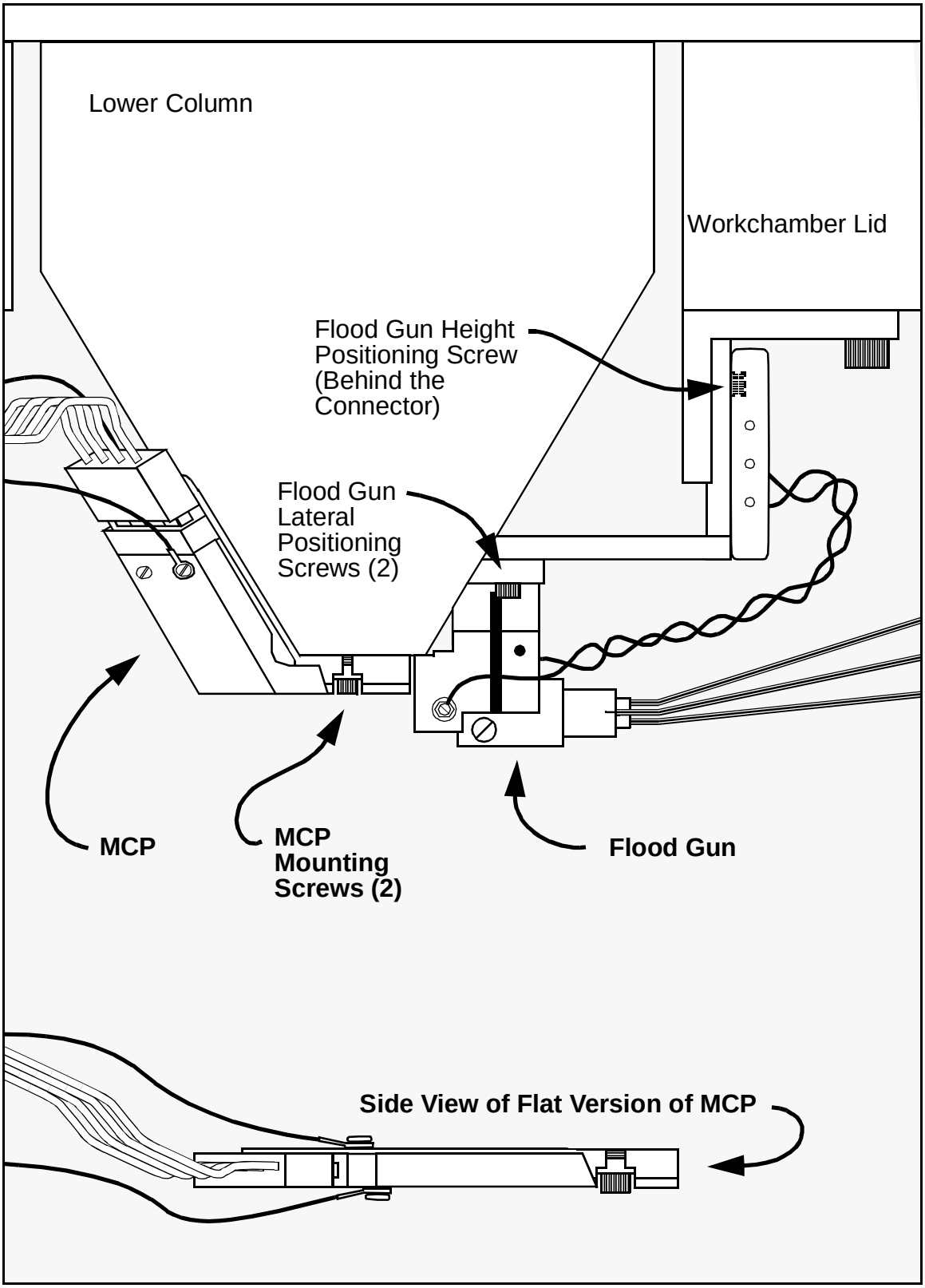

Lower Column
Workchamber Lid
Flood Gun Height Positioning Screw (Behind the Connector)
Flood Gun Lateral Positioning Screws (2)
MCP
MCP Mounting Screws (2)
Flood Gun
Side View of Flat Version of MCP

Figure 2. Side View of Flood Gun Without Snout and Small MCP(s)

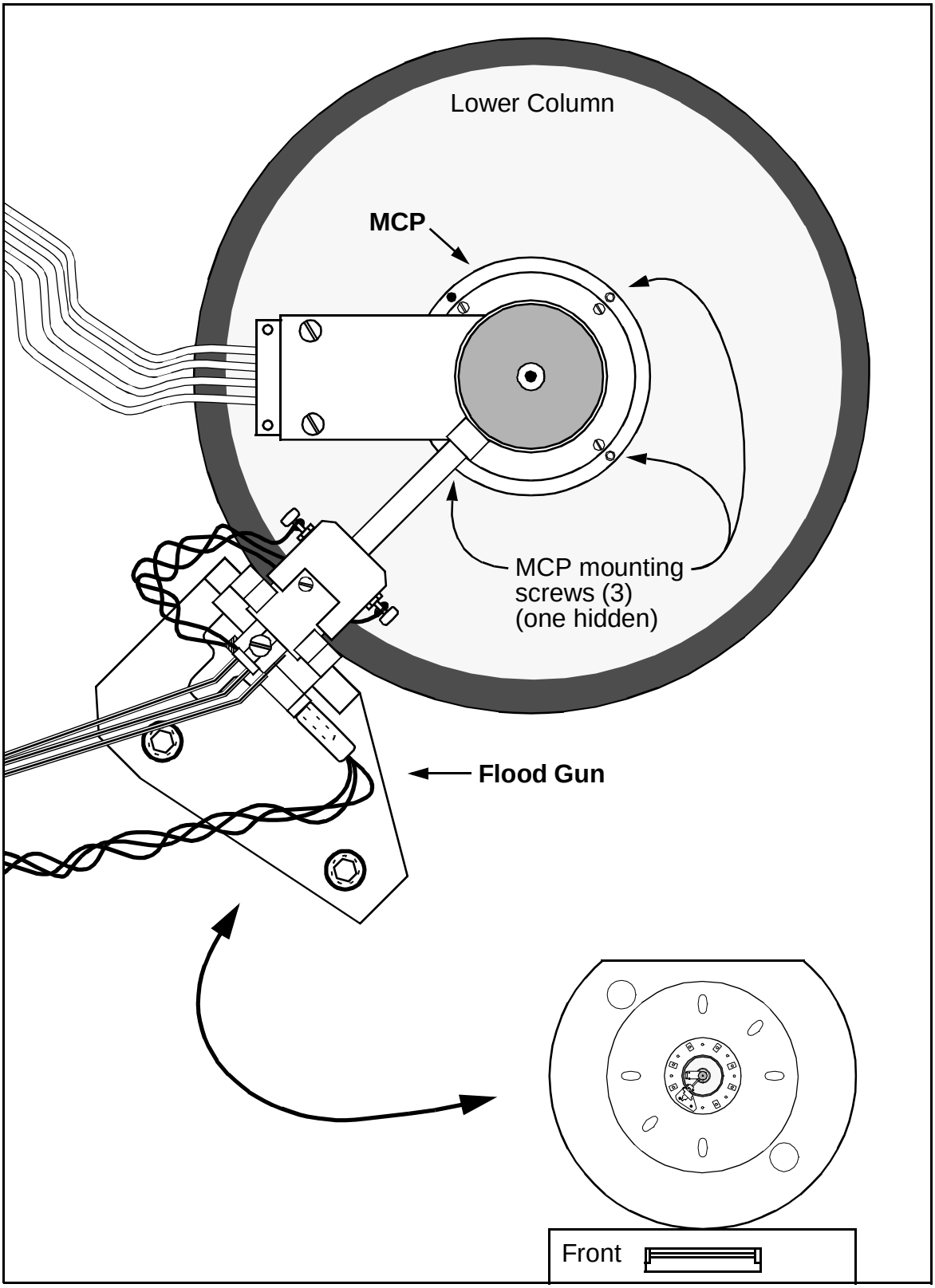


Figure 3. Flood Gun With Snout and Large MCP: Interior View

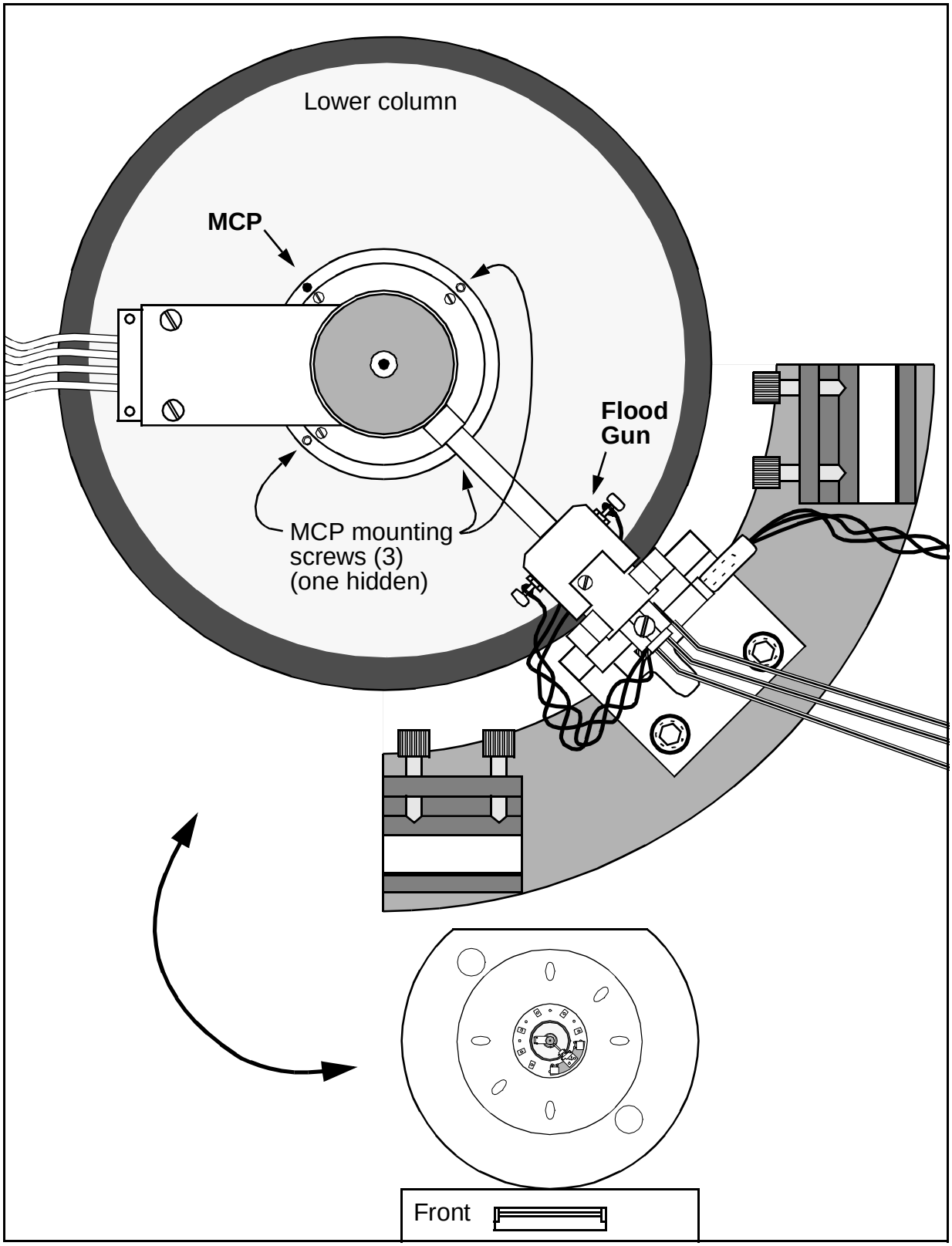


Figure 4. Flood Gun With Snout and Large MCP in 9800 System: Interior View

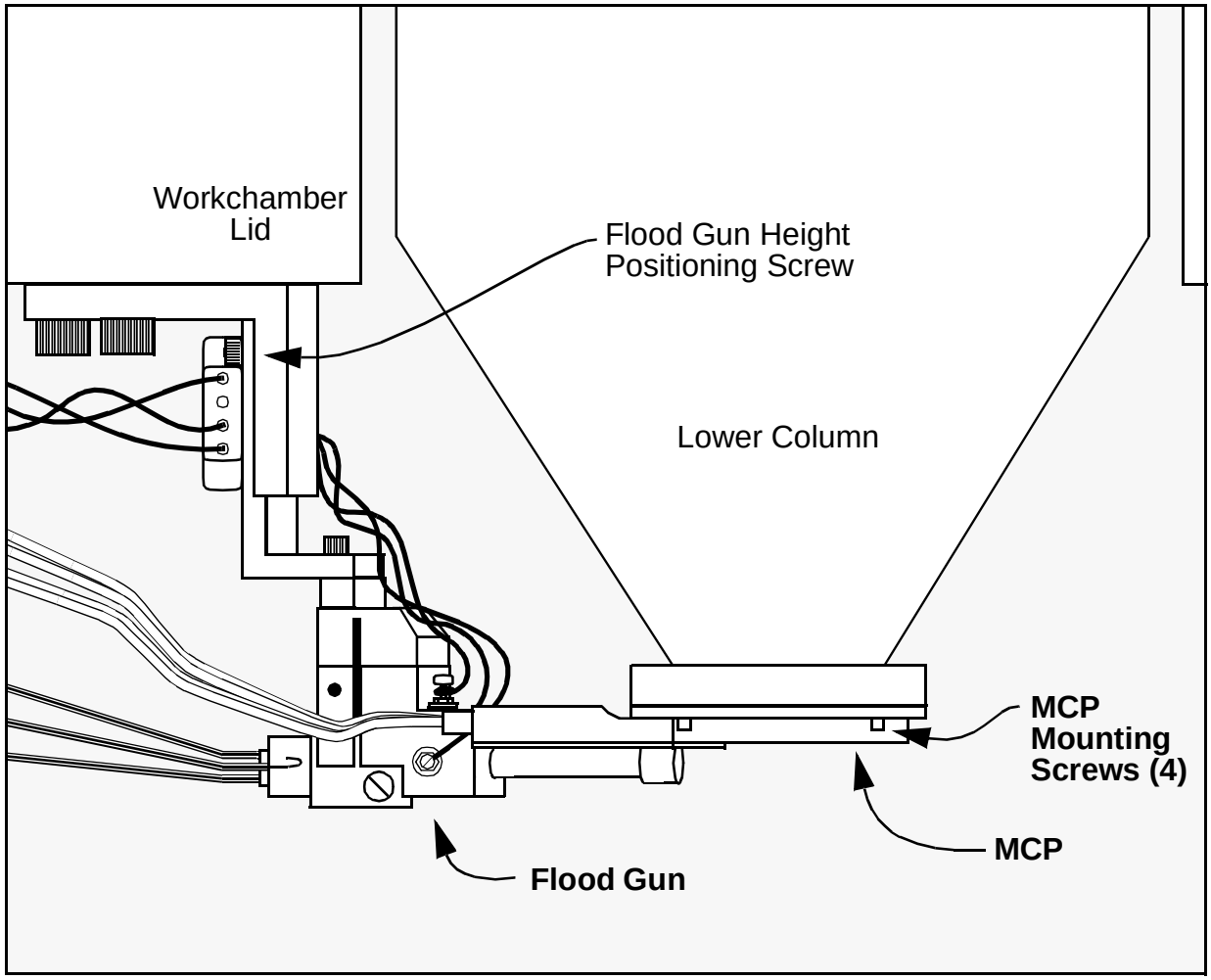


Figure 5. Side View of Flood Gun With Snout and Large MCP

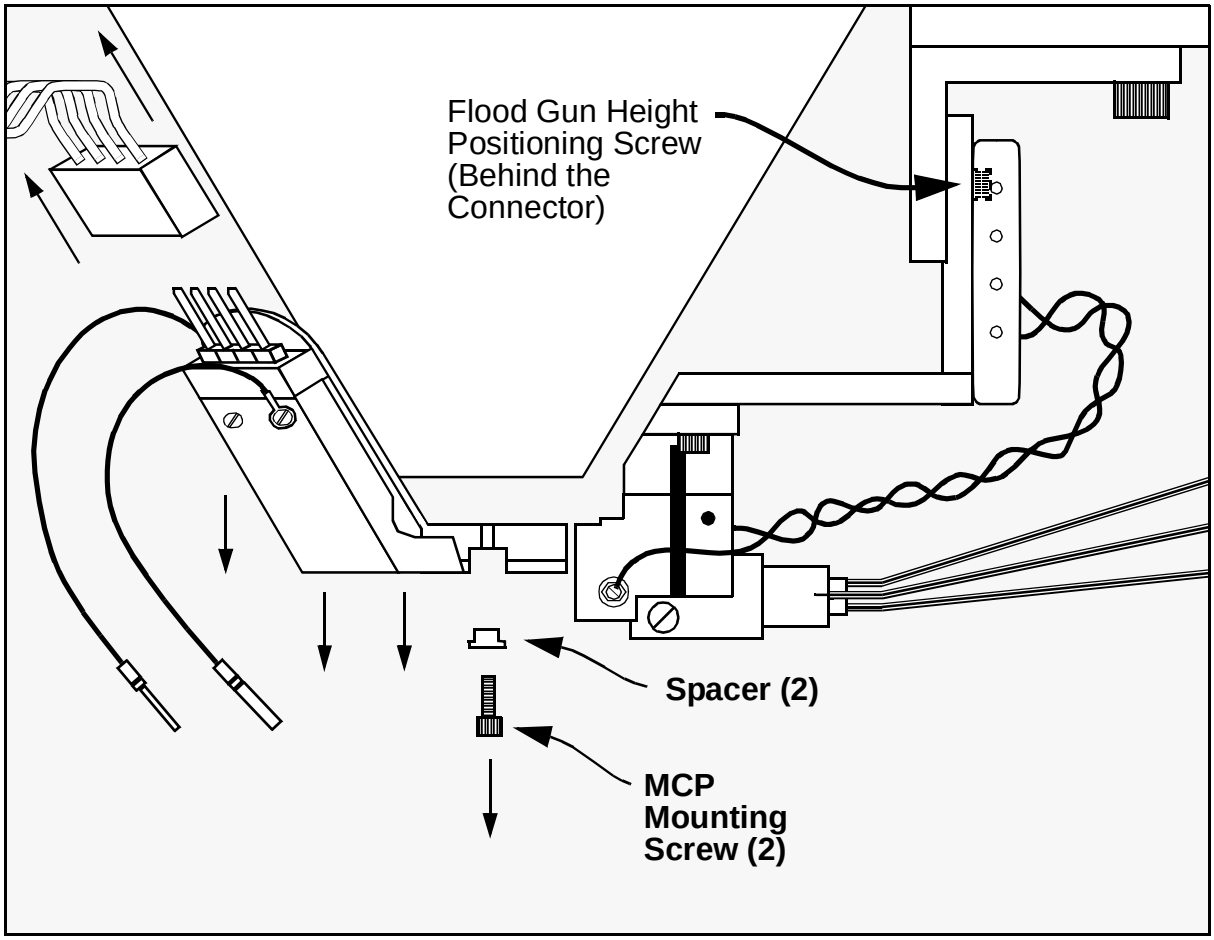


Figure 6. Side View of Flood Gun Without Snout and Small MCP: Flood Gun Lowered and MCP Disconnected.

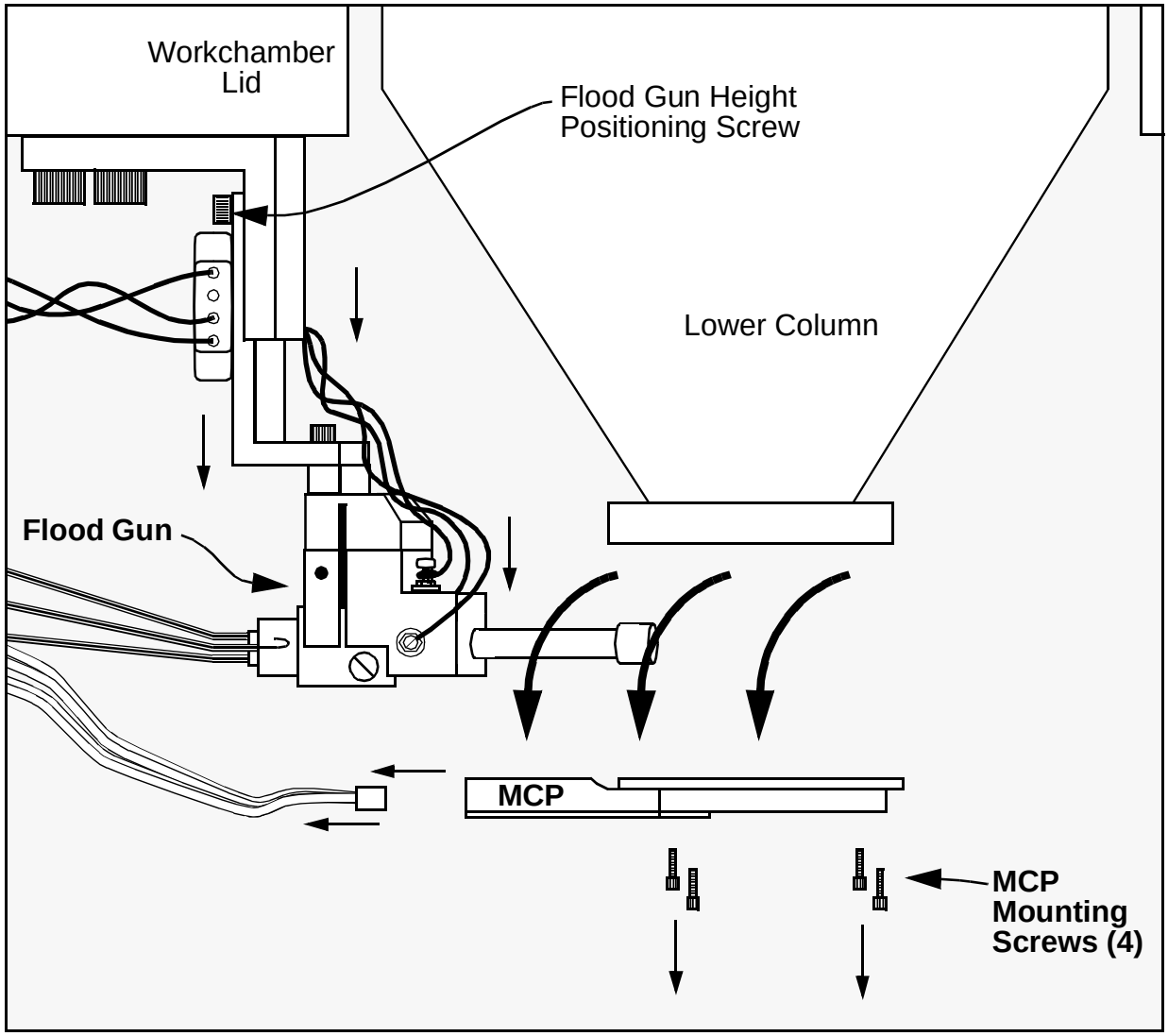


Figure 7. Side View of Flood Gun With Snout and Large MCP: Flood Gun Lowered and MCP Disconnected.

Part 3. Replacing the MCP

3-1. Fasten the replacement MCP to the bottom of the column with the MCP mounting screws (see Figures 6 and 7).

3-2. Reattach the MCP electrical connectors.

3-3. Slide the flood gun subassembly up until it contacts the lower column. Make sure that the flood gun is aligned with (points directly at) the center bore of the MCP (see Figures 1, 2, 3, 4, and 5). Tighten the flood gun height positioning screw (see Figures 2 and 5).

3-4. Clean the workchamber (see Service Procedure 06-03), then close the workchamber door.

3-5. Power up the system as described in Service Procedure 01-01, and pump down the system as described in Service Procedure 04-03.

Micrion

Service Procedure No.: **05-03-25**
Service Procedure Title: **MCP Removal and Replacement: 25 nm Column**
Applicable Systems: **8000, Micrion 9800 FlipChip**
Frequency of Service: **As needed.**

Introduction

This procedure describes the removal of the microchannel plate (MCP) from the column of the FIB system, and the installation of a replacement MCP.

Materials Required

This procedure requires the use of the following materials:

- Clean, standard field service kit
- Lint-free wipes
- Clean-room gloves
- Laboratory-grade isopropyl alcohol

NOTICE

Per paragraph 11.1 of Safety Guidelines for Semiconductor Manufacturing Equipment (S2-93), this procedure is a Type 5 task. Specifically: "Equipment is energized and measurements and adjustments require physical entry into the equipment, or equipment configuration will not allow the use of clamp-on probes."

Part 1. System Preparation

Configure the Chemical Sources in "Safe" Mode

Before performing the tasks described in this procedure, you must put the chemical sources in a "safe" mode; see Service Procedure 02-01.

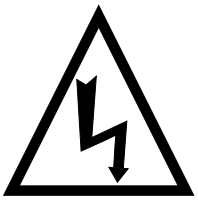
WARNING

Do not proceed until the chemical sources are secure. The chemical reservoirs in FIB systems contain hazardous materials. Labels affixed to the exterior of a chemical cabinet identify the chemical(s) contained inside. If a chemical source is not in its "safest" state, as described in **Service Procedure 02-01**, it is possible for a combination of component failures to release the chemical(s) through a cabinet's delivery line, a roughing line, a purging line, or from a chemical reservoir into the workchamber. Do not open the workchamber, or disassemble any part of the vacuum pumping system, or detach any gas line from any chemical cabinet until you are sure that every chemical source attached to the FIB system is in its "safest" state.

Power Down and Vent the System

Before performing the tasks described in this procedure, you must power down and vent the system; see Service Procedure 01-02.

WARNING



Dangerously high voltages are present in the process module while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and automatic procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

Clean off the exterior of the system as well as the floor; see Service Procedure 06-05.

Open the Workchamber

Remove the front panels to gain access to the workchamber door.

Once the system is completely vented, open the workchamber door by removing the 1/2" socket head cap screws.

WEAR GLOVES, DO NOT HANDLE SOLVENTS

When working inside the chamber or when handling any components that will be exposed to vacuum, wear gloves rated for Class 100 environments or better. Due to disintegration of such gloves by solvents, do not handle solvents or parts that are wet with solvent.

Part 2. Removing the MCP

2-1. After the system has vented, open the workchamber. Figures 1, 2, and 3 show the location of the flood gun and the MCP. Note that the position of the flood gun is different in a 9800 series system (as shown in Figure 2); the flood gun is rotated 90° to accommodate the installation of an optical microscope.

2-2. Wearing clean room gloves, loosen the flood gun height positioning screw (see Figures 3 and 4) and slide the flood gun assembly down to provide access to the MCP.

2-3. Remove the MCP electrical connector (see Figures 3 and 4).

NOTICE: DO NOT DROP MOUNTING SCREWS

Before removing and replacing the MCP, place a clean lint-free wipe below the MCP to prevent the mounting screws from falling into the turbo pump or the stage hardware. **If a screw or spacer is dropped into the workchamber, be sure to retrieve it before proceeding.**

2-4. Remove the MCP from the bottom of the column by removing the four socket head mounting screws (see Figures 1, 2, 3, and 4). Be careful not to damage the MCP screen. Close the workchamber door.

Note: to eliminate the risk of dropped hardware, remove the column (as described in Service Procedure 05-09-25), replace the MCP, and then reinstall the column.

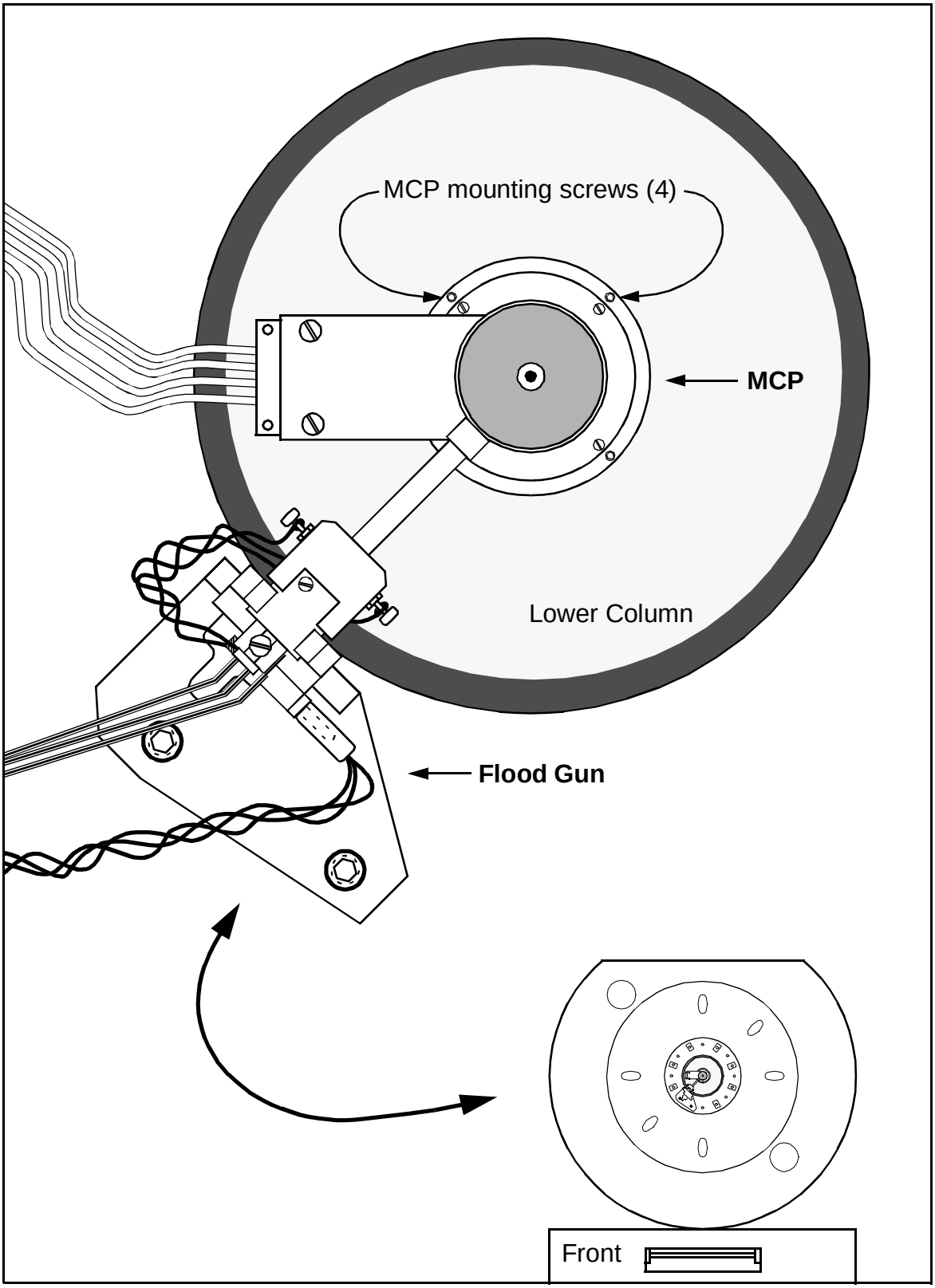


Figure 1. Interior View of Flood Gun and MCP: 25 nm Column in 8000 System

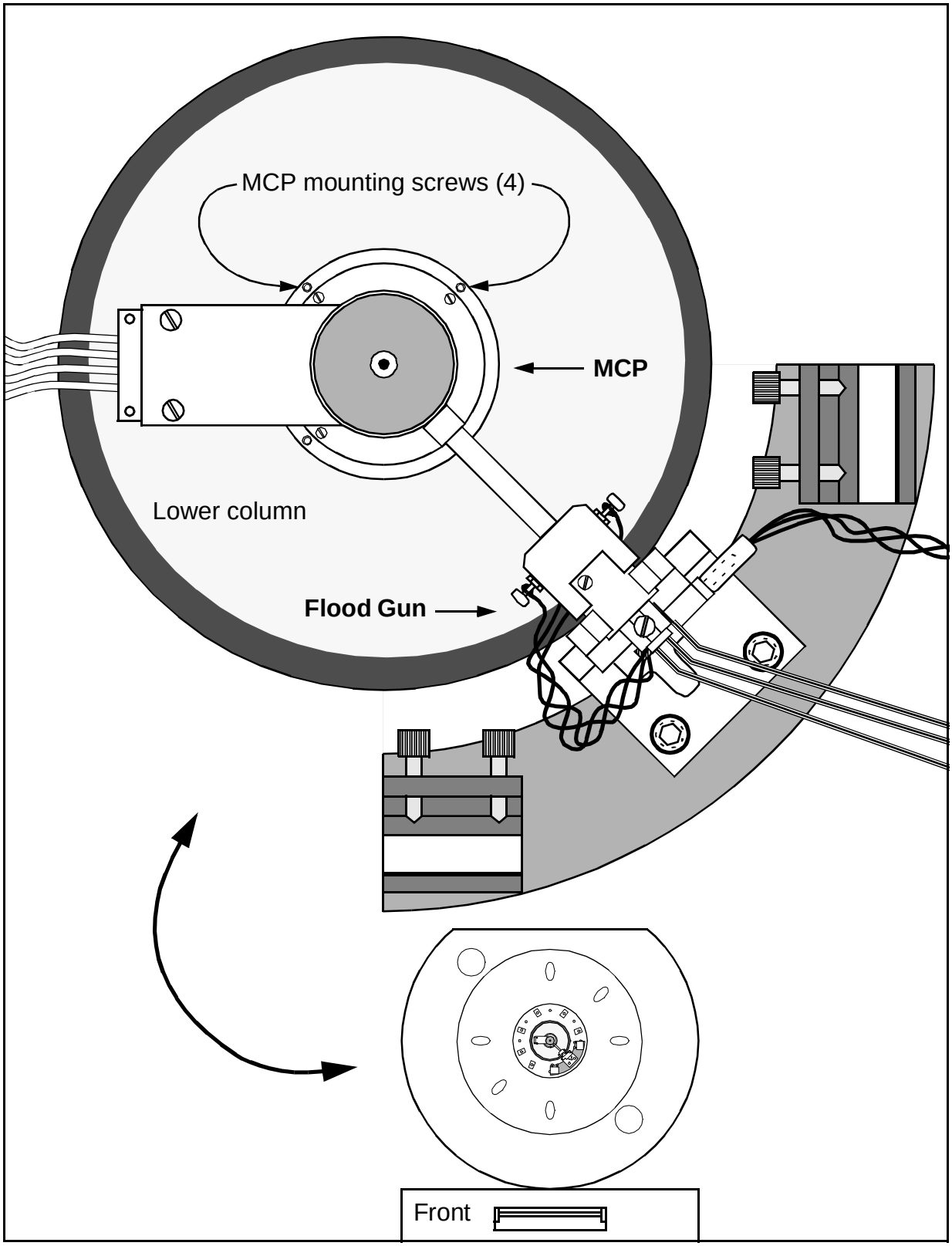


Figure 2. Interior View of Flood Gun and MCP: 25 nm Column in 9800 System

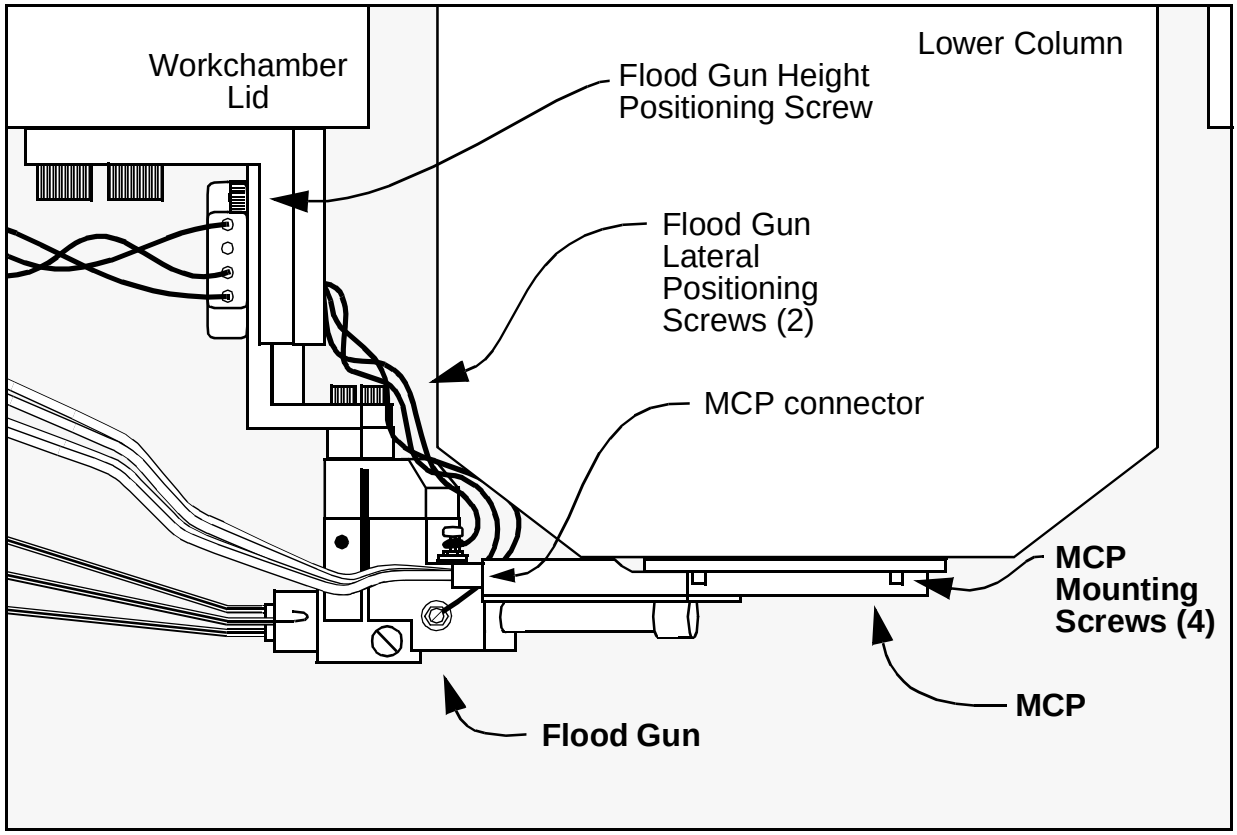


Figure 3. Side View of Flood Gun and MCP

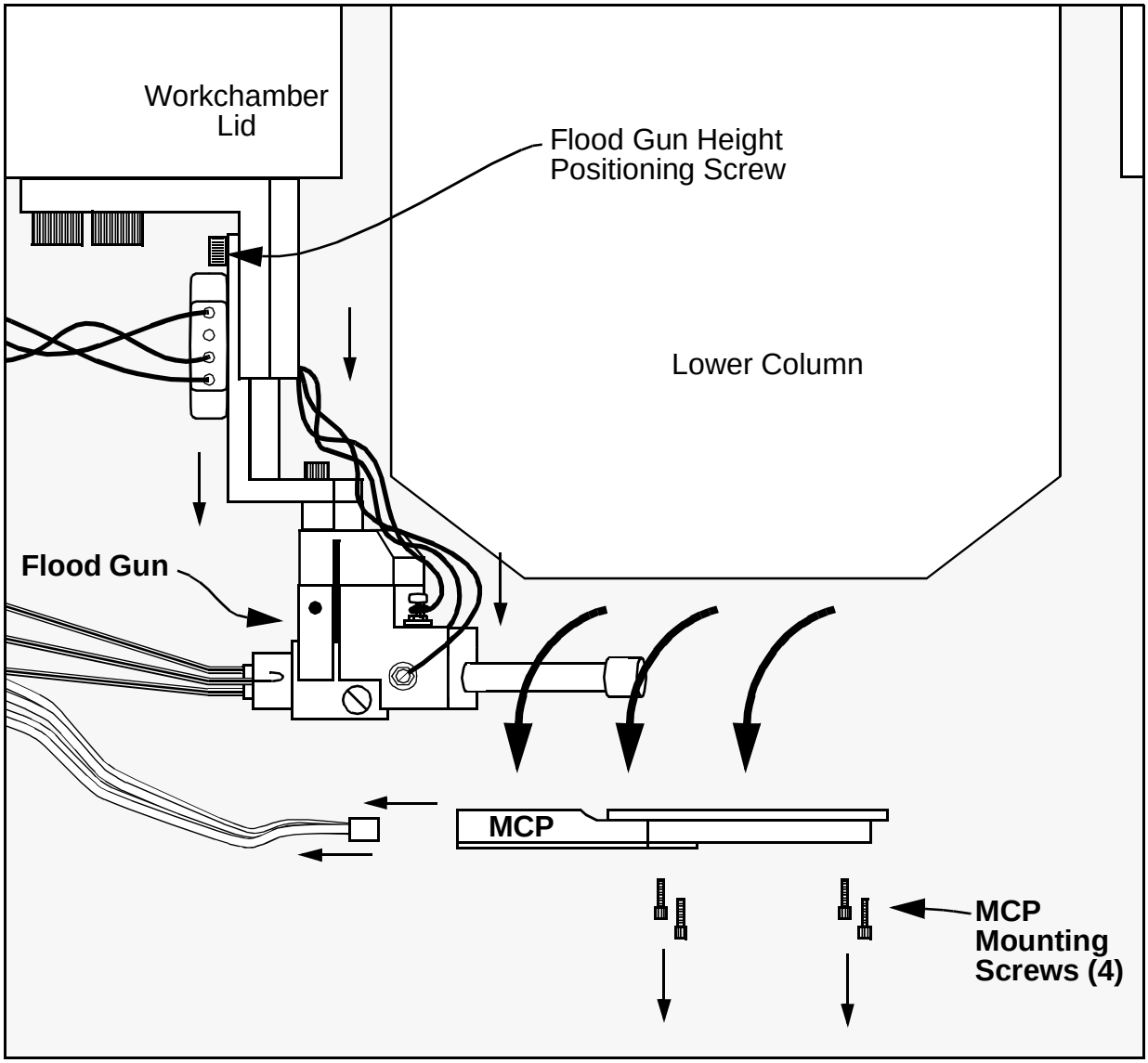


Figure 4. Flood Gun Lowered and MCP Disconnected: Side View

Part 3. Replacing the MCP

3-1. Fasten the replacement MCP to the bottom of the column with the four MCP mounting screws (see Figure 4).

3-2. Reattach the MCP electrical connector (see Figures 1, 2, and 3).

3-3. Slide the flood gun subassembly up until it contacts the MCP as shown in Figures 1, 2, and 3. Make sure that the flood gun is aligned with (points directly at) the center bore of the MCP. Tighten the flood gun height positioning screw.

3-4. Clean the workchamber (see Service Procedure 06-03), then close the workchamber door.

3-5. Power up the system as described in Service Procedure 01-01, and pump down the system as described in Service Procedure 04-03.

Micrion

Service Procedure No.: **05-04-05**
Service Procedure Title: **Flood Gun Removal and Replacement: 5 nm Column**
Applicable Systems: **8000, Micrion 9800 FlipChip, MicroMill HT**
Frequency of Service: **As needed**

Introduction

The electron flood gun (also called the E-Gun) provides charge neutralization of the sample. The flood gun voltage is supplied by the flood gun supply board (150-001130) and is controlled by the flood gun interface board (150-001090).

Materials and Tools Required

- Tie-wrap
- Voltmeter with at least 10 Megohm input impedance
- Picoammeter (Optional)
- BNC - Dual Banana Adapter
- Clip leads
- Coax cable (6 feet)
- E-Gun Board Test Circuit
- Schematic 163-00342X (E-Gun Harness)
- Clean, standard field service tool kit

This procedure uses diagnostic methods published in Tech Note 002, “Flood Gun Diagnostics.”

NOTICE

Per paragraph 11.1 of *Safety Guidelines for Semiconductor Manufacturing Equipment* (S2-93), this procedure is a Type 5 task. Specifically: “Equipment is energized and measurements and adjustments require physical entry into the equipment, or equipment configuration will not allow the use of clamp-on probes.”

Installation Pre-Check

Prior to the installation, visually check that the flood gun and the snout bore are free from contamination. Also perform the continuity checks to ensure that the filament is not open and none of the snout elements are shorted.

Part 1. System Preparation

Configure the Chemical Sources in "Safe" Mode

Before performing the tasks described in this procedure, you must put the chemical sources in a "safe" mode; see Service Procedure 02-01.

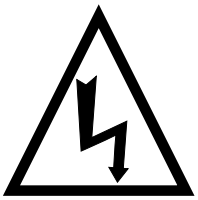
WARNING

Do not proceed until the chemical sources are secure. The chemical reservoirs in FIB systems contain hazardous materials. Labels affixed to the exterior of a chemical cabinet identify the chemical(s) contained inside. If a chemical source is not in its "safest" state, as described in **Service Procedure 02-01**, it is possible for a combination of component failures to release the chemical(s) through a cabinet's delivery line, a roughing line, a purging line, or from a chemical reservoir into the workchamber. Do not open the workchamber, or disassemble any part of the vacuum pumping system, or detach any gas line from any chemical cabinet until you are sure that every chemical source attached to the FIB system is in its "safest" state.

Power Down and Vent the System

Before performing the tasks described in this procedure, you must power down and vent the system; see Service Procedure 01-02.

WARNING



Dangerously high voltages are present in the process module while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and automatic procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

Clean off the exterior of the system as well as the floor; see Service Procedure 06-05.

Open the Workchamber

Remove the front panels to gain access to the workchamber door.

Once the system is completely vented, open the workchamber door by removing the 1/2" socket head cap screws.

Part 2. Remove the Flood Gun

2-1. After the system has vented, open the workchamber. Three types of flood gun/MCP configurations are installed in FIB systems with 5 nm columns:

- a flood gun without a snout combined with a small MCP (as shown in Figures 1 and 2)
- a flood gun with a snout paired with a large MCP[1] (as shown in Figures 3, 4, and 5)
- a low-profile flood gun without a snout, used on MicroMill HT models (as shown in Figure 6), which has its own procedure for removal included in Figure 6.

2-2. Remove the flood gun electrical connectors: disconnect the grid lead, the two filament leads, and the 4-pin keyed connector (see Figures 1, 3, and 4).

NOTICE: DO NOT DROP MOUNTING SCREWS

Before removing and replacing the flood gun, place a clean lint-free wipe below the flood gun to prevent the mounting screws from falling into the turbo pump or the stage hardware. **If a screw is dropped into the workchamber, be sure to retrieve it before proceeding.**

2-3. Remove the flood gun from the workchamber lid by removing the two mounting screws as shown in Figures 3 and 4. Be careful not to damage the MCP screen.

[1] There are two configurations of the flood gun with a snout and large MCP combination (see Figures 3 and 4). In a 9800 series system (as shown in Figure 4), the flood gun is rotated 90° to accommodate the installation of an optical microscope.

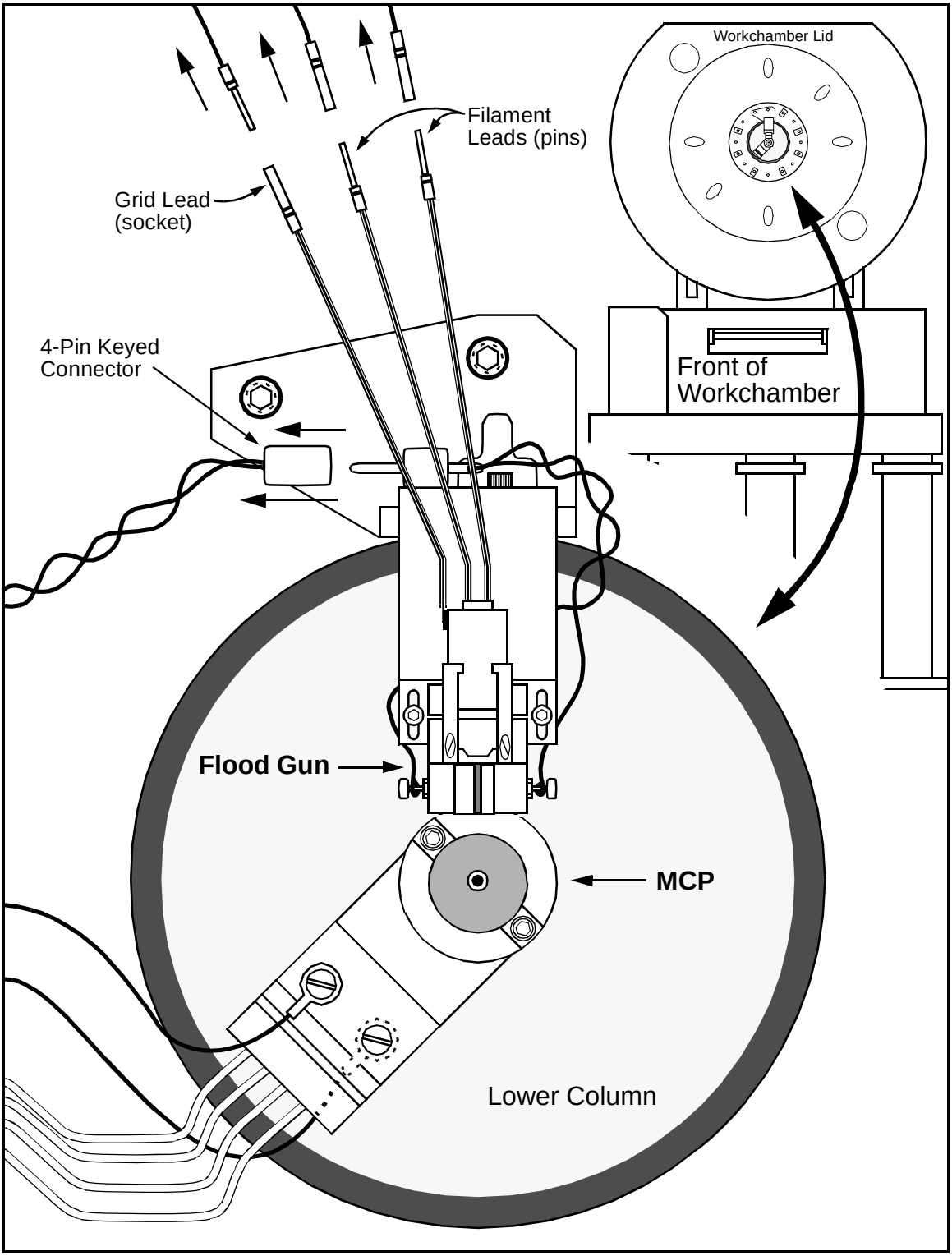


Figure 1. Flood Gun Without Snout and Small MCP: Interior View

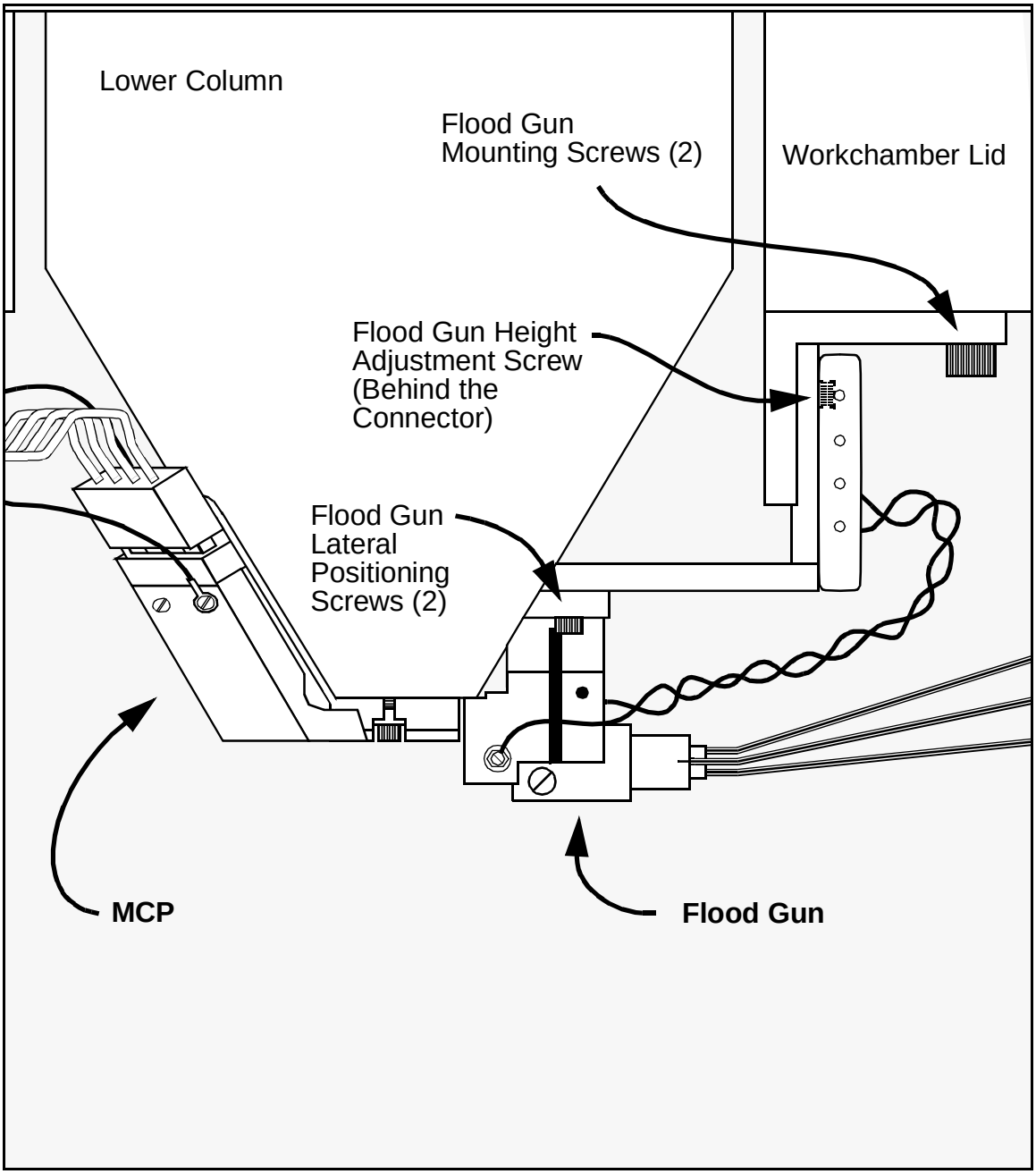


Figure 2. Flood Gun Without Snout and Small MCP(s): Side View

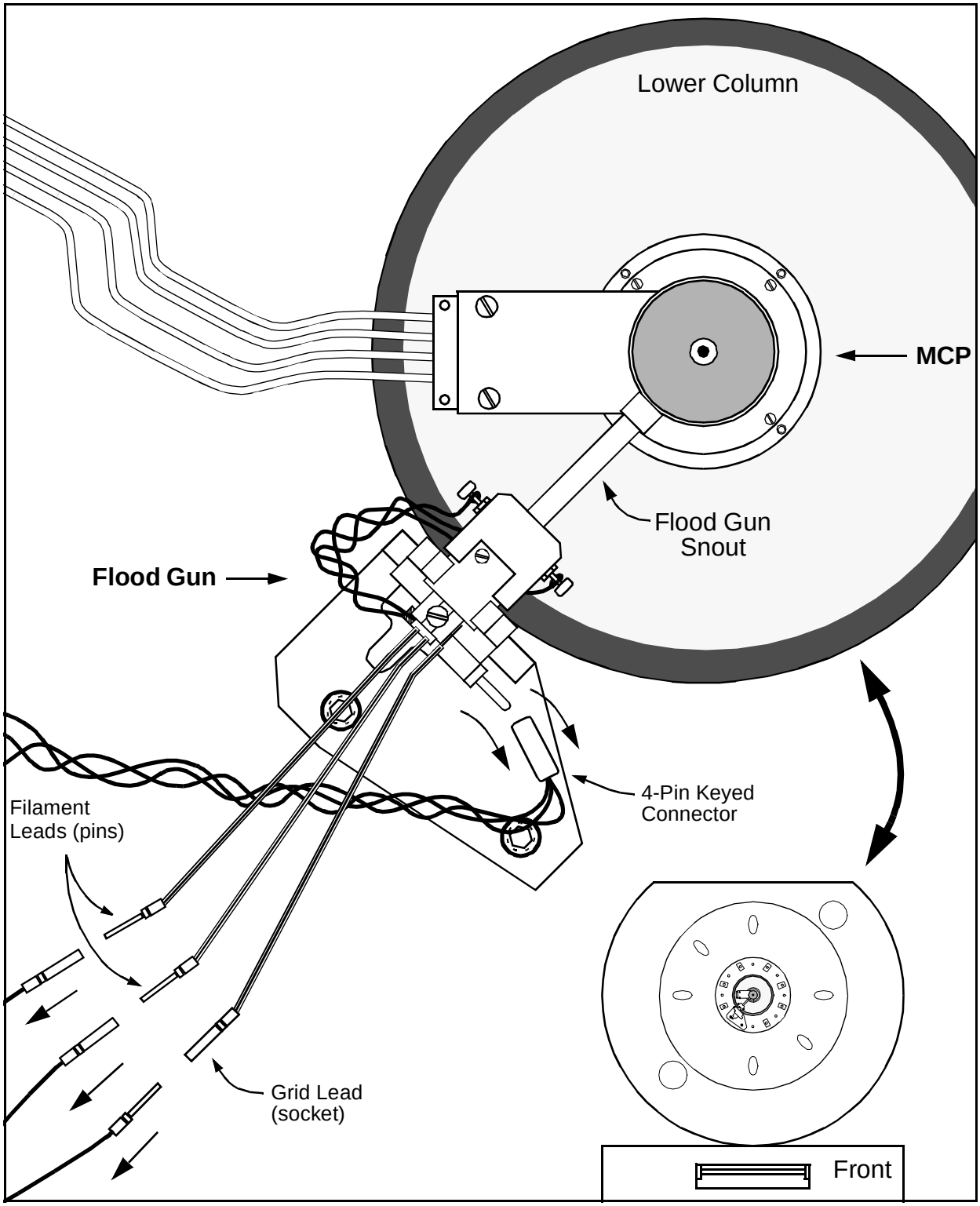


Figure 3. Flood Gun With Snout and Large MCP: Interior View

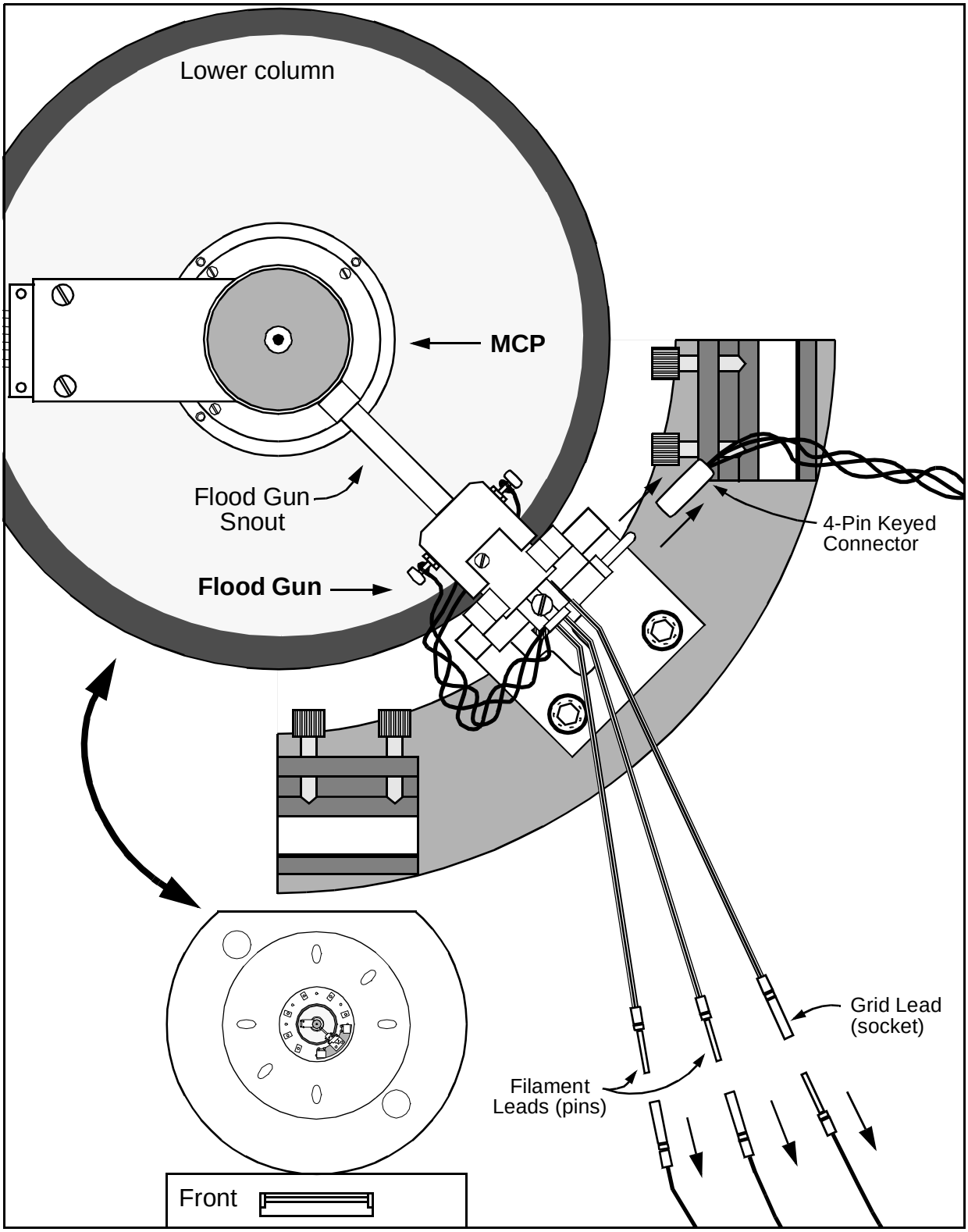


Figure 4. Flood Gun With Snout and Large MCP in 9800 System: Interior View

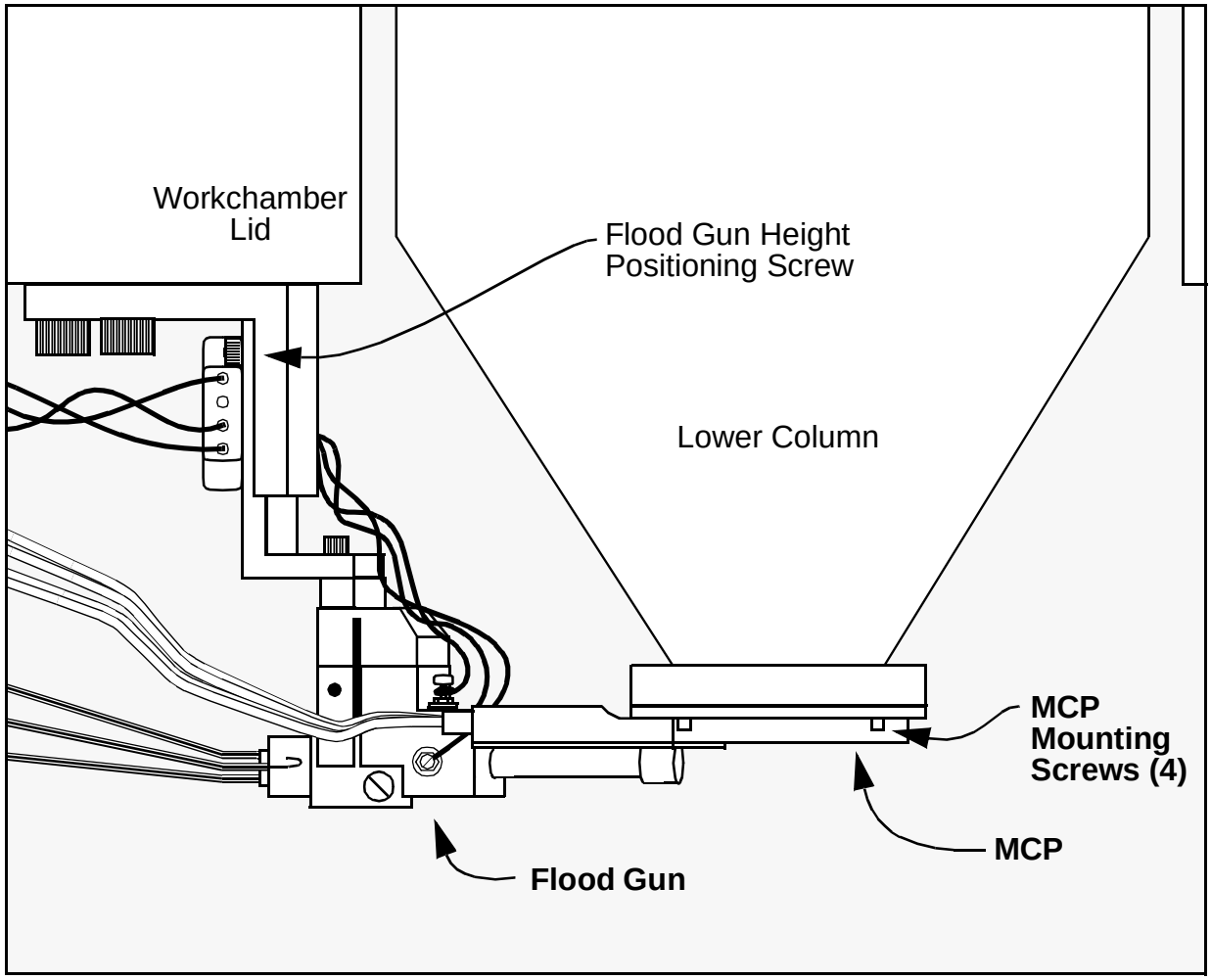


Figure 5. Flood Gun With Snout and Large MCP: Side View

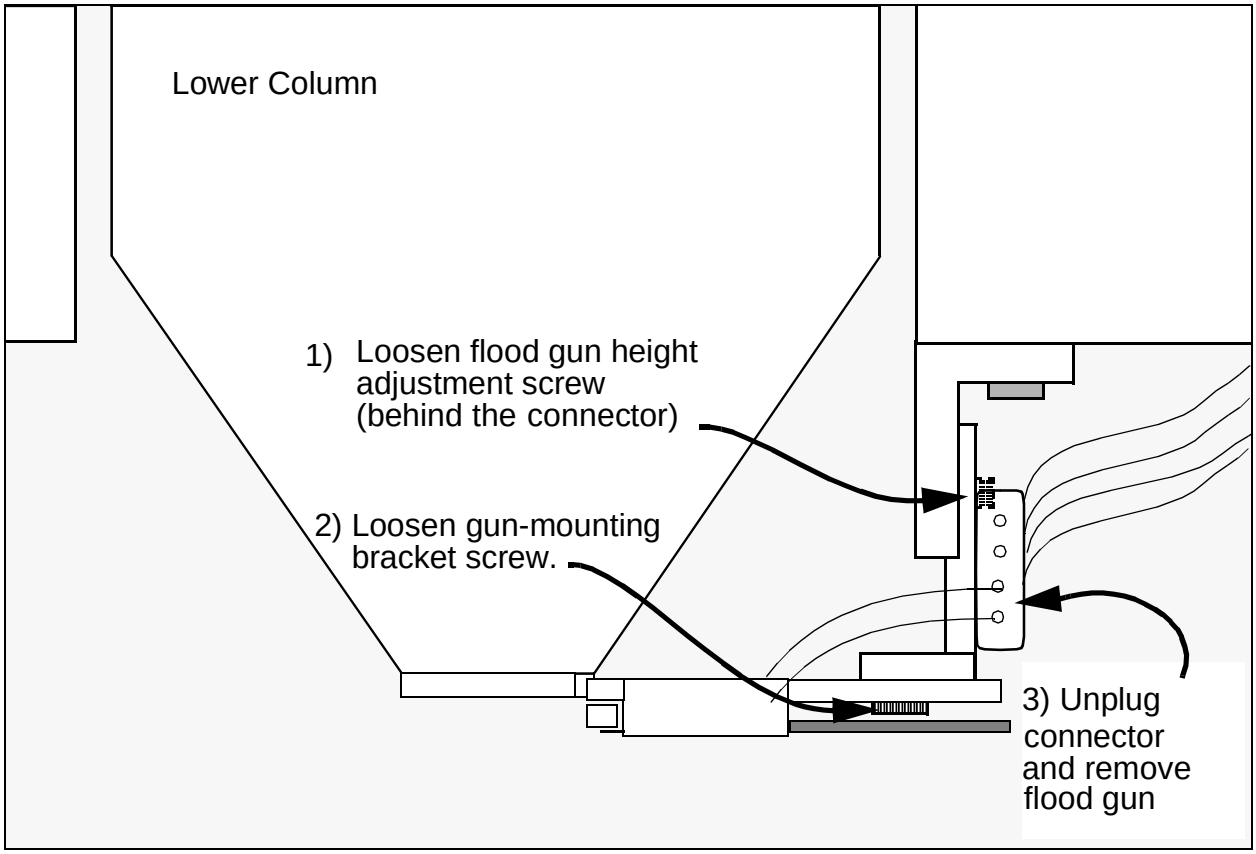

Lower Column
1) Loosen flood gun height adjustment screw (behind the connector)
2) Loosen gun-mounting bracket screw.
3) Unplug connector and remove flood gun

Figure 6. Low-Profile Flood Gun with Removal Procedure: Side View

Part 3. Inspect and Test the Replacement Flood Gun

NOTICE: THE FLOOD GUN AND ITS COMPONENTS ARE FRAGILE

Handle the flood gun with care. The flood gun leads are somewhat brittle and will break if they are bent back and forth excessively.

3-1. Remove the shipping screw.

3-2. Loosen the height adjustment screw. Slide the upper bracket as far away from the lower flood gun as the height adjustment screw allows, then tighten the height adjustment screw.

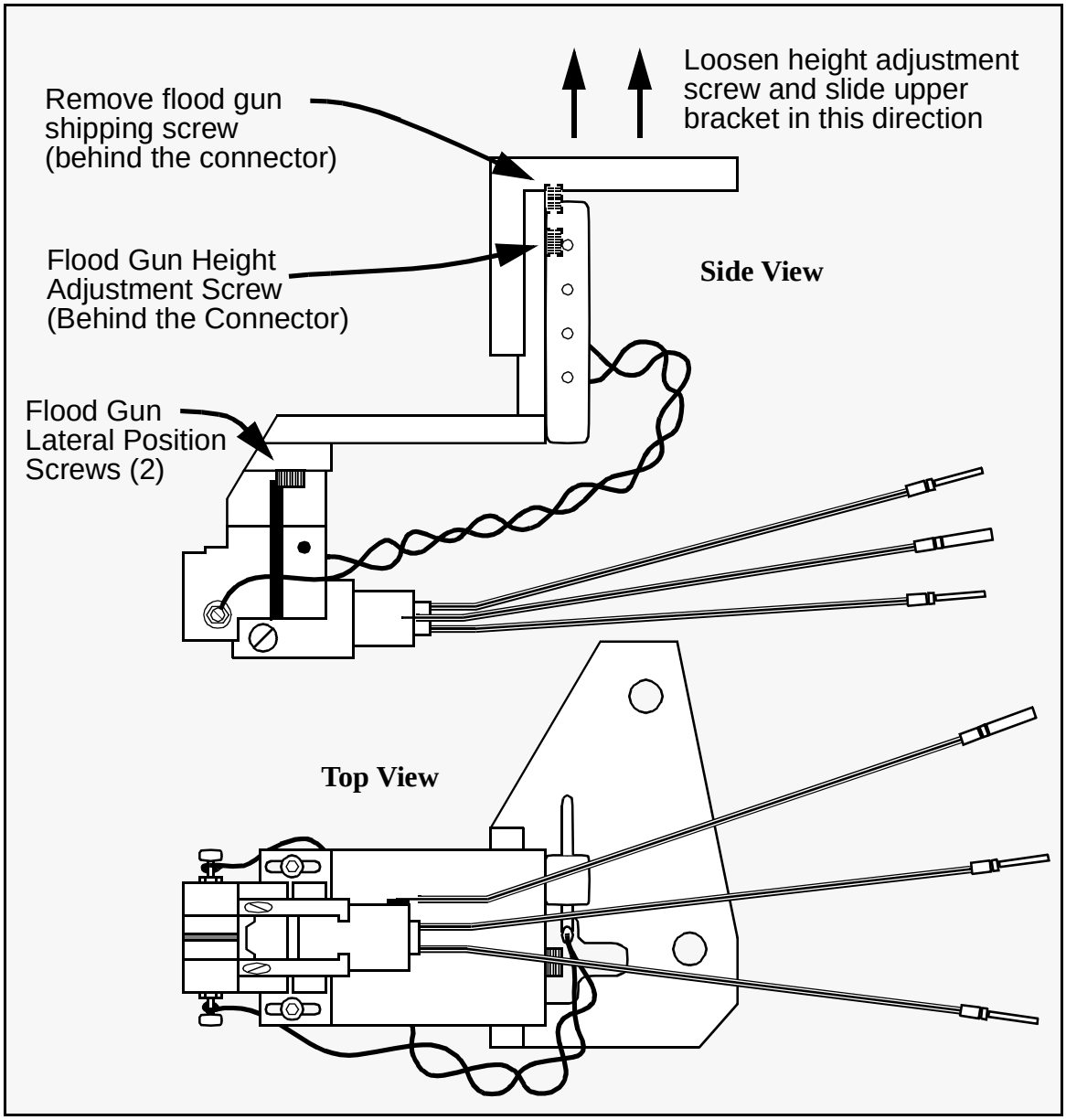

Loosen height adjustment screw and slide upper bracket in this direction
Remove flood gun shipping screw (behind the connector)
Flood Gun Height Adjustment Screw (Behind the Connector)
Side View
Flood Gun Lateral Position Screws (2)
Top View

Figure 7. Replacement Flood Gun Without Snout: Side and Top Views

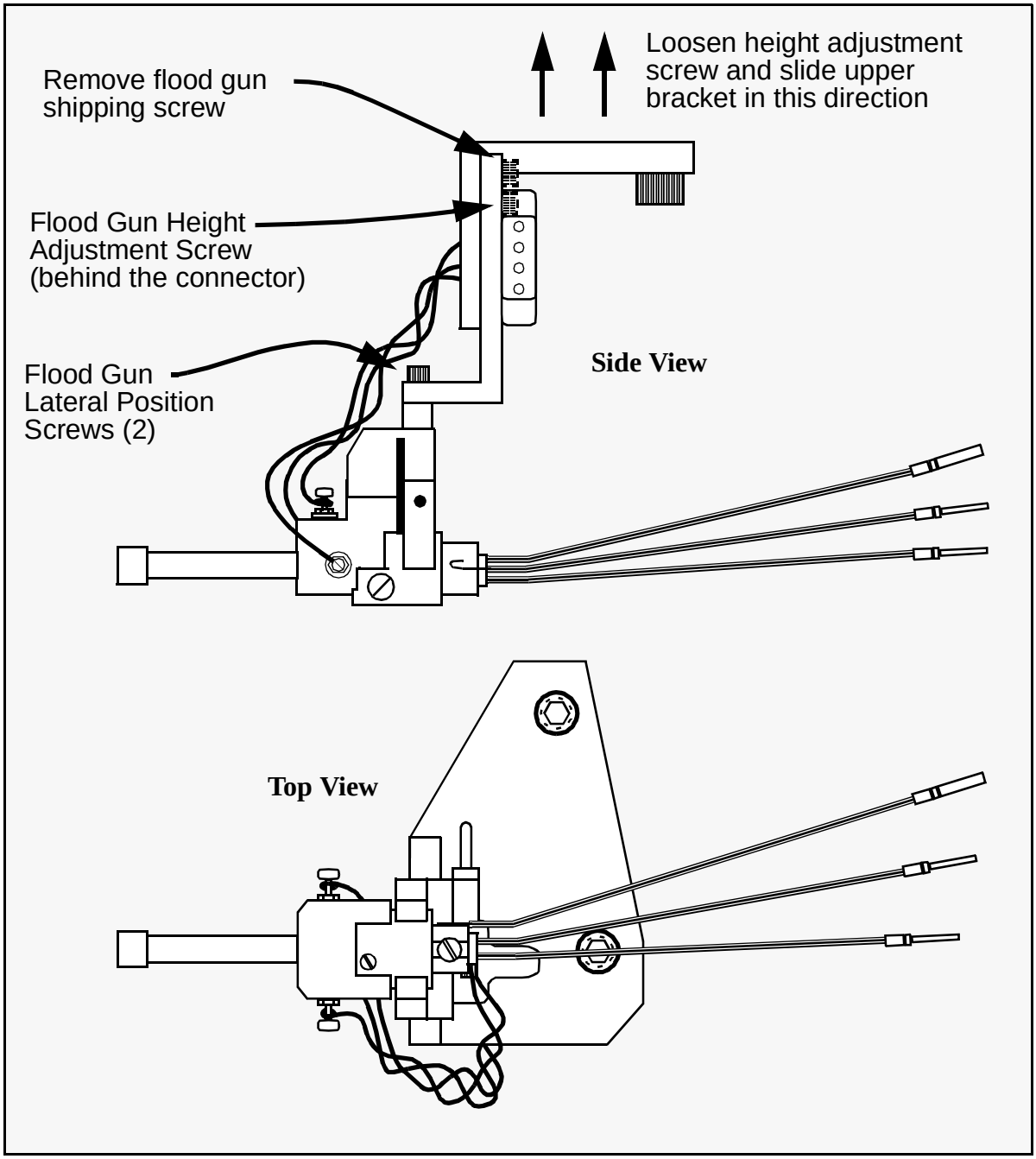

Remove flood gun shipping screw
Loosen height adjustment screw and slide upper bracket in this direction
Flood Gun Height Adjustment Screw (behind the connector)
Flood Gun Lateral Position Screws (2)
Side View
Top View

Figure 8. Replacement Flood Gun With Snout: Side and Top Views

3-3. Continuity Tests:

a. To test a flood gun without a snout, use an ohmmeter to perform the continuity tests listed in Table 1. The test measurement points are shown in Figure 8. If the measurements do not match those in Table 1, contact Micrion Customer Support.

b. To test a flood gun with a snout, use an ohmmeter to perform the continuity tests listed in Table 2. The test measurement points are shown in Figure 9. If the measurements do not match those in Table 2, contact Micrion Customer Support.

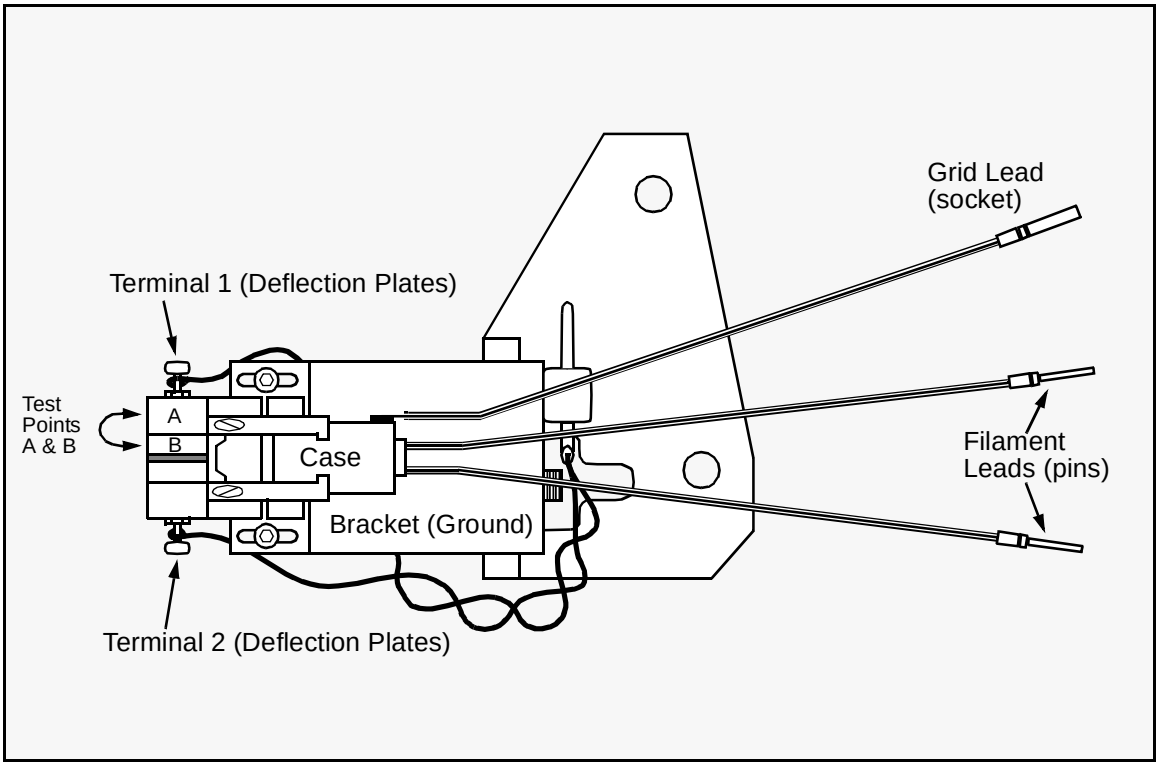


Figure 9. Flood Gun Without Snout: Continuity Test Points

Table 1: Flood Gun Without Snout: Continuity Tests

From	To	Continuity
Point A	Point B	Not Continuous
Filament Lead 1	Filament Lead 2	Continuous
Filament Lead (either)	Ground	Not Continuous
Filament Lead (either)	Grid Lead	Not Continuous
Terminal 1	Ground	Not Continuous
Terminal 2	Ground	Not Continuous
Case	Ground	Not Continuous

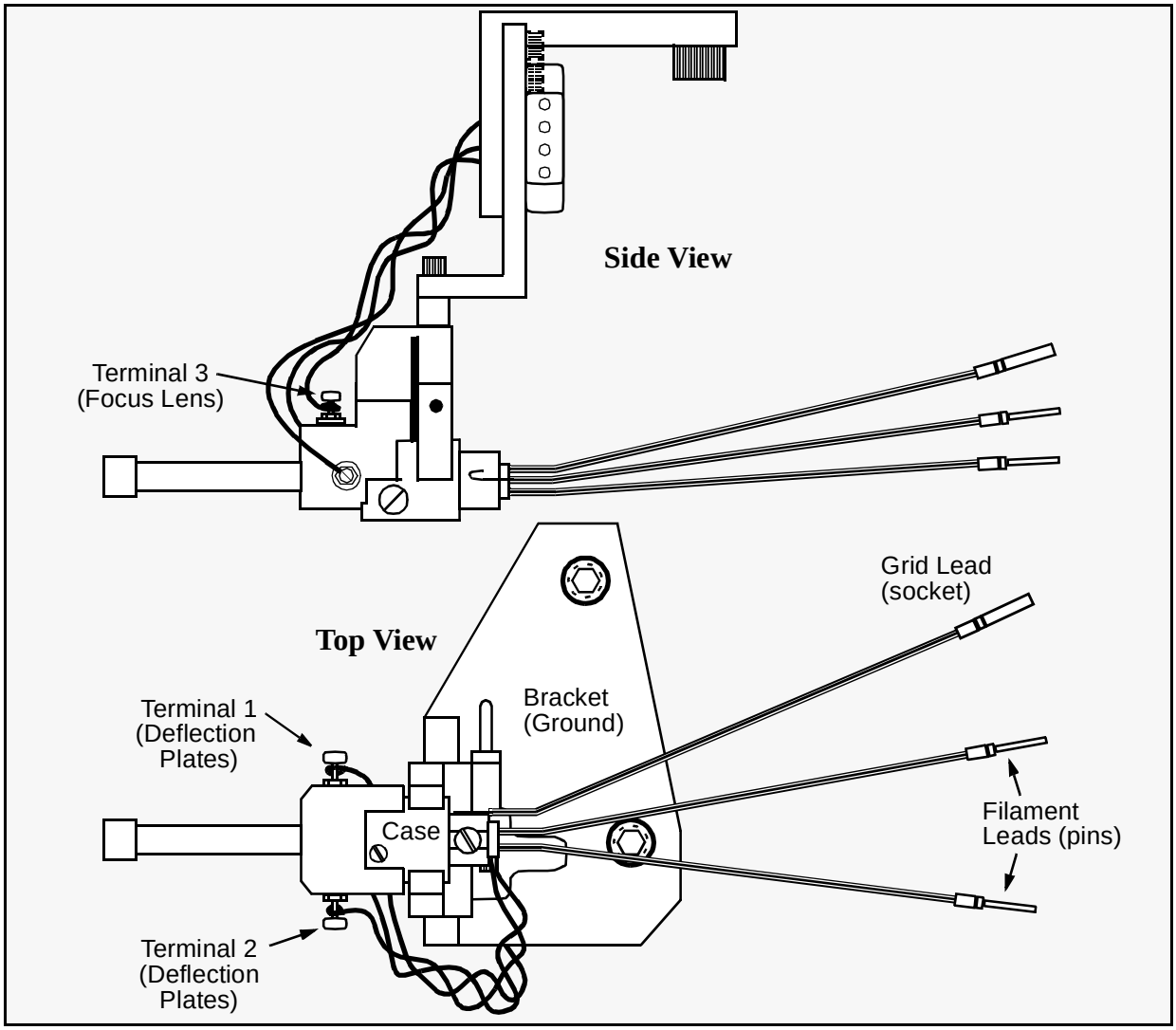


Figure 10. Flood Gun With Snout: Continuity Test Points

Table 2: Flood Gun With Snout: Continuity Tests

From	To	Continuity
Filament Lead 1	Filament Lead 2	Continuous
Filament Lead (either)	Ground	Not Continuous
Filament Lead (either)	Grid Lead	Not Continuous
Terminal 1	Ground	Not Continuous
Terminal 2	Ground	Not Continuous
Terminal 3	Terminals 1 & 2	Not Continuous
Case	Ground	Not Continuous

Part 4. Install the Replacement Flood Gun

4-1. Fasten the flood gun assembly to the Workchamber Lid with the mounting screws (see Figures 10 and 11).

4-2. Flood gun adjustment (be careful not to damage the MCP screen during the adjustment):

a. To adjust a flood gun without a snout, loosen the height adjustment screw and slide the flood gun up until the lower portion of the flood gun assembly contacts (is flush against) the lower column cover (see Figures 1, 2 and 10). Make sure that the flood gun is aligned with (points directly at) the center bore of the MCP (see Figure 1). If necessary, loosen the lateral positioning screws and adjust the lateral position of the flood gun to obtain a good fit against the lower column cover.

b. To adjust a flood gun with a snout, loosen the height adjustment screw and slide the flood gun up until the end of the flood gun snout contacts the MCP as shown in Figures 3, 4, 5, and 11. Be careful not to damage the MCP screen. Make sure that the flood gun snout is aligned with (points directly at) the center bore of the MCP (see Figures 1 and 2). If necessary, loosen the lateral positioning screws and adjust the lateral position of the flood gun to obtain the proper orientation against the MCP (see Figure 6).

4-3. Tighten the height (and, if used, the lateral) adjustment screw(s).

4-4. Reattach the flood gun electrical connections as shown in Figures 1, 3, and 4.

4-5. Clean the interior of the system as described in Service Procedure 06-03.

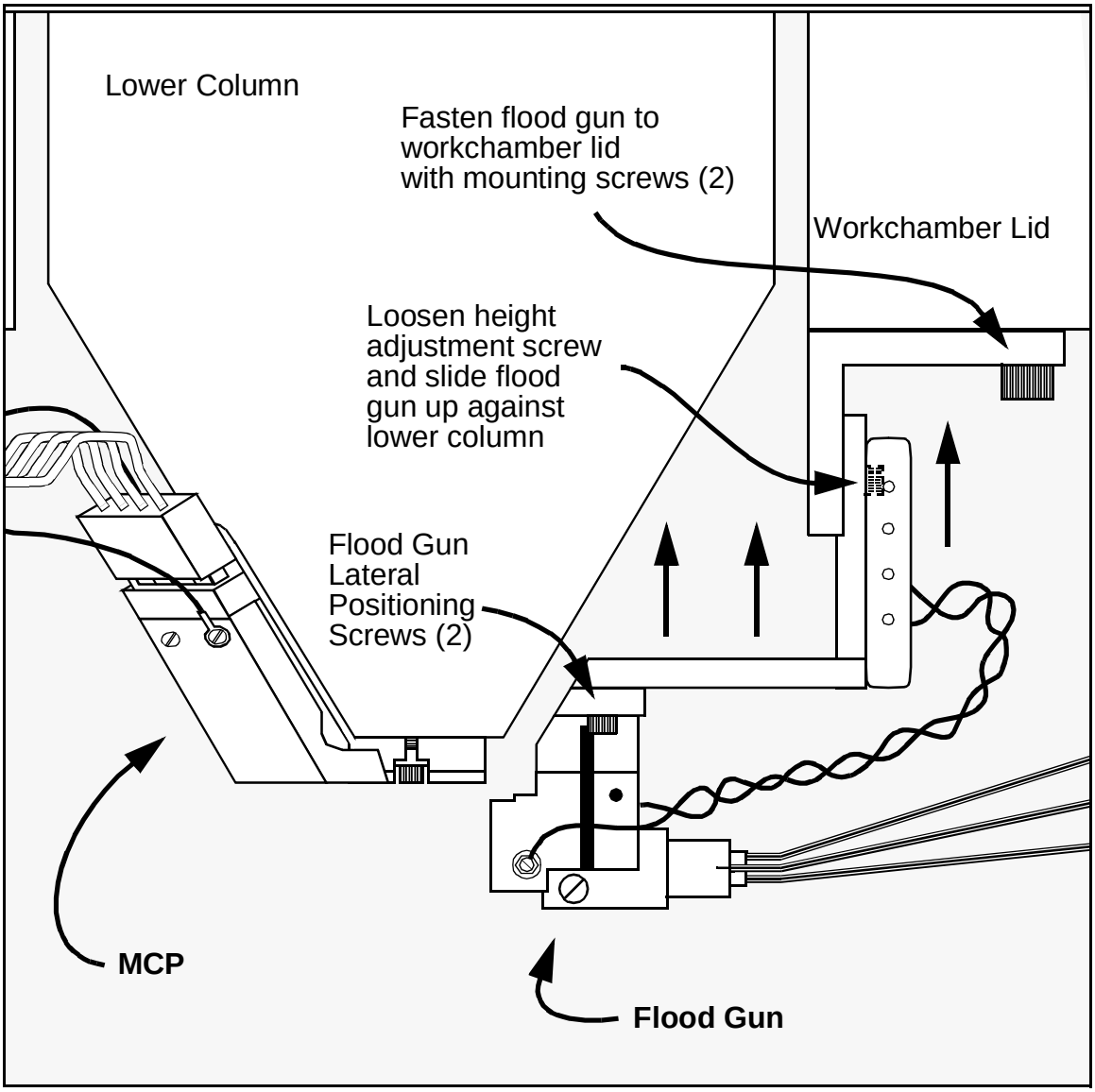

Lower Column
Fasten flood gun to workchamber lid with mounting screws (2)
Workchamber Lid
Loosen height adjustment screw and slide flood gun up against lower column
Flood Gun Lateral Positioning Screws (2)
MCP
Flood Gun

Figure 11. Installation of Replacement Flood Gun Without Snout

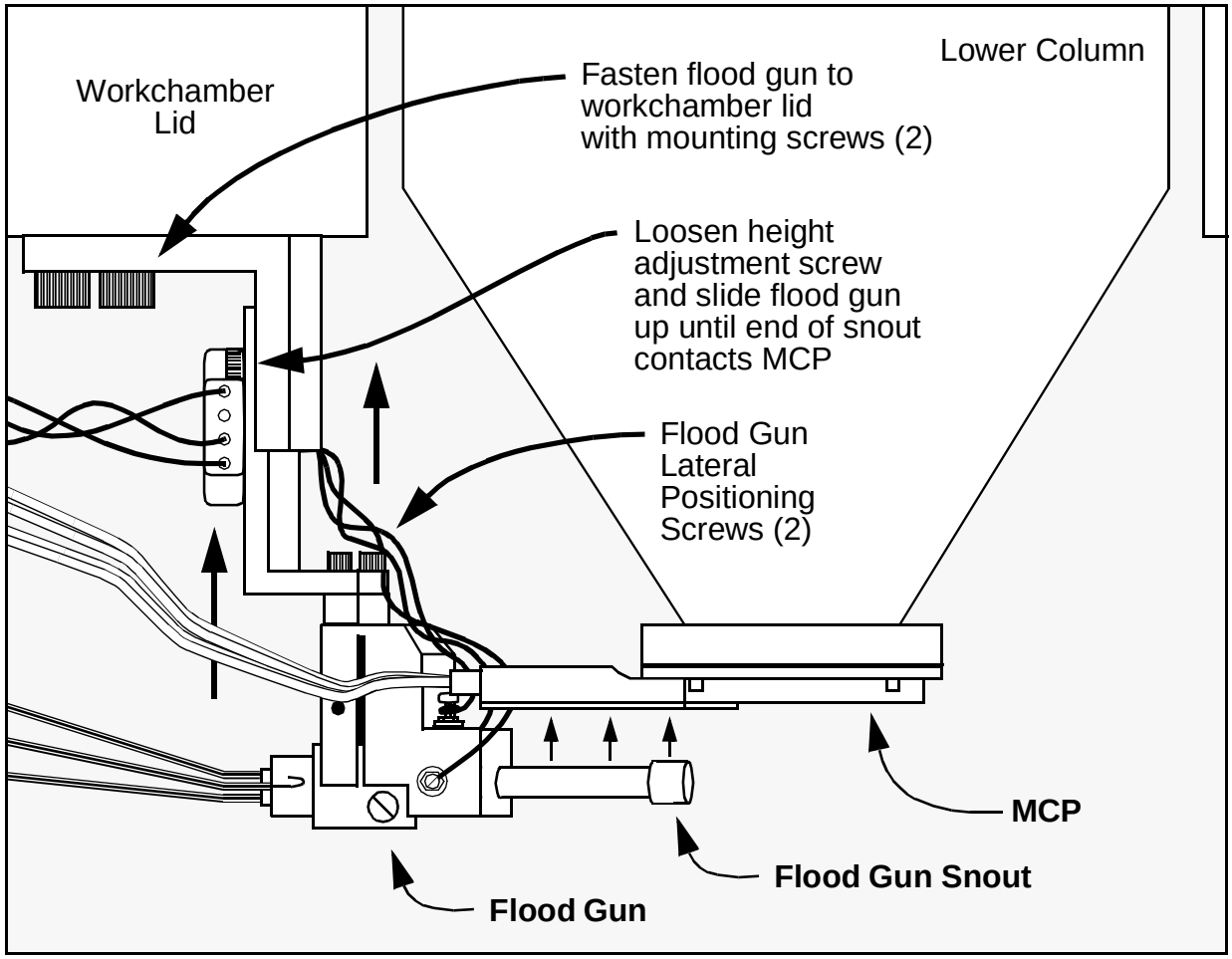

Workchamber Lid
Lower Column
Fasten flood gun to workchamber lid with mounting screws (2)
Loosen height adjustment screw and slide flood gun up until end of snout contacts MCP
Flood Gun Lateral Positioning Screws (2)
MCP
Flood Gun Snout
Flood Gun

Figure 12. Installation of Replacement Flood Gun With Snout

Part 5. Power Up and Beam Up

Follow Service Procedure 01-01 to power up and bring the beam up.

Part 6. Flood Gun Control/Calibration

The Electron Flood Gun popup provides access to an automated calibration function and allows manual control of the potentials applied to the flood gun elements. This popup is accessible either through the Microsurgery program's Misc menu (select *E-Gun Control*), or through the Beam Screen (click on the flood gun graphic located to the immediate right of the image area).

An automatic calibration function is available through the Electron Flood Gun popup. To use it, make sure that the system is in ion imaging mode, and then click on the *Calibrate* button in the popup. The calibration function brings the electron faraday under the column, sweeps the various flood gun control potentials to obtain optimum current in the faraday, and then returns the stage to its former position.

To obtain popups for manually changing the potentials applied to the flood gun elements, click on the graphical representations of the elements in the Electron Flood Gun popup. For manual intervention, you must disable the flood gun maintenance software function (with the *Maintenance* button in the Electron Flood Gun popup), which monitors and adjusts the filament current to maintain constant emission (cathode current).

Part 7. Checking the Flood Gun Boards (150-001130/150-001090).

7-1. If the system is currently up, perform an Auto power down and switch off the System Controller Chassis, as explained in Service Procedure 01-02.

7-2. Remove all external connections from the 150-001130 board. (See Service Procedure 12-11, Flood Gun Supply Board, for connectors.)

7-3. Remove the 150-001130 board from its slot, place it on an extender card, and put the extender in the slot.

7-4. Switch on the System Controller Chassis. (See Service Procedure 01-01.)

7-5. Referring to Service Procedure 12-12, verify that all the proper supply voltages are present on the board.

7-6. Switch off the System Controller Chassis and return the 150-001130 board to its slot.

7-7. Repeat steps 7-2 through 7-6 for the 150-001090 board. (See Service Procedure 12-11, Flood Gun Interface Board.)

7-8. Reconnect all external connections to the 150-001130 and 150-001090 boards.

7-9. Switch on the System Controller Chassis.

7-10. Switch on the Computer and wait for the bootstrap to complete.

7-11. When prompted, log in as *micrion*.

Part 8. E-Gun Resistance Checks

8-1. In the flood gun control popup:

a. Click on the filament graphic to obtain the filament control popup, and manually slide the filament control to any value and then back to ZERO.

b. Set the remaining sliders to the following values:

Grid - 0, Focus - 0, Cathode - 0, Deflection - 0, Screen - 0.

8-2. Remove the cable from connector J1801 on the E-Gun feedthrough port. Connector J1801 and the E-Gun feedthrough port are located on the right side (looking from the front of the system) of the workchamber lid. The harness number on the label should be 160-003422.

8-3. Check the connector pins on the feedthrough port (the wire harness between the feedthrough and the flood gun; not the harness between the System Controller and the feedthrough) as follows:

a. Check between pins E, F (filament), you should have continuity. If not, the E-gun filament or internal harness is open.

b. Check between pins U, G, and H (Focus lens to Deflection plates). They should be open.

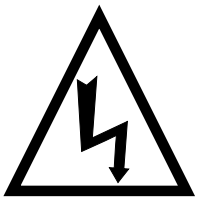
c. Check between pins T and E or F (Filament and Grid elements). They should be open.

d. Check E, F, G, H, T and U to ground. They should all be open.

Part 9. E-Gun Assembly Voltage Checks

For the following steps, use the control sliders in the popups for the focus and deflection elements. Change the slider settings and watch how both the measured (metered) and system readback voltages vary. Make sure that changes are smooth and linear over the entire slider range. If there are large jumps or other erratic behavior, a DAC, ADC or power supply may be failing. Please note the following hazard warning and take the safety precautions prescribed.

WARNING



Electrical potentials as high as 500 volts may be present at the J1801 connector when the flood gun power switch (S3) on the System Controller is in the ON position. When taking the voltage measurements described below, be sure to switch the flood gun power switch OFF before connecting or disconnecting the voltmeter probes.

9-1. Check the positive deflection voltage control as follows:

a. Switch the flood gun power switch (S3) on the System Controller OFF.

b. Connect the voltmeter between pins G (Ydef+) and P (Ground).

c. Switch the flood gun power switch (S3) on the System Controller ON.

d. Sweep the deflection slider slowly through its range and verify that the positive voltage is the same magnitude as the negative voltage (0 V to +/- 10 V), and that the readbacks track the voltmeter.

9-2. Check the negative deflection voltage control as follows:

a. Switch the flood gun power switch (S3) on the System Controller OFF.

b. Connect the voltmeter between pins H (Ydef-) and P (Ground). NOTE: This will be opposite in polarity to pin G above.

c. Switch the flood gun power switch (S3) on the System Controller ON.

d. Sweep the deflection slider slowly through its range and verify that the negative voltage is the same magnitude as the positive voltage (0 V to +/- 10 V), and that the readbacks track the voltmeter.

9-3. Check the filament voltage control as follows:

a. Make sure that the system is in ion imaging mode and that the flood gun is unblanked.

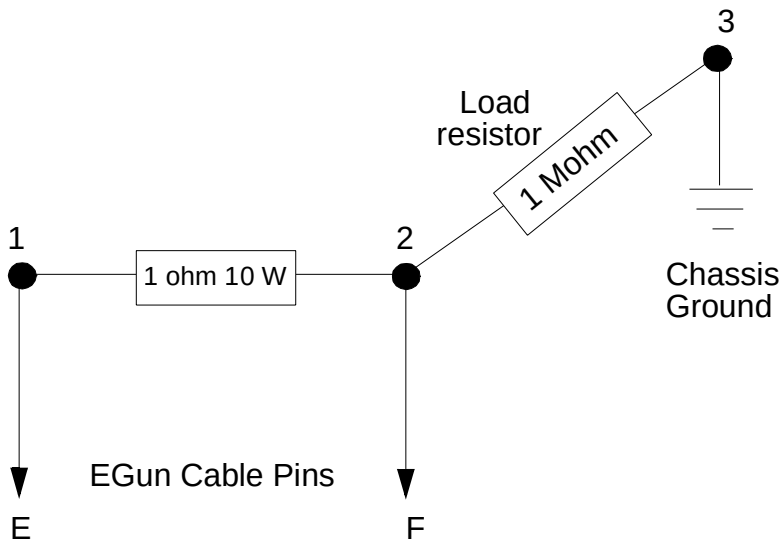
a. Switch the flood gun power switch (S3) on the System Controller OFF.

b. Connect the “Flood Gun Board Test Circuit” to pins E and F (Filament supply) of the cable connector and connect point 3 to chassis ground with a clip lead (see Fig. 6).

c. Switch the flood gun power switch (S3) on the System Controller ON.

d. Sweep the filament slider slowly through its range. Verify that the proper voltages are present and that the system readbacks track the voltmeter.

e. Disconnect the “Flood Gun Board Test Circuit”.



Point 1 to Point 2: Filament Current (I=E/R), which calculates to what is on the slider.
Point 2 to Ground: Cathode Voltage (CATV)
CATC readback on the beam control screen should equal CATV/ 1 Mohm
(If no 10W resistor is available, you can use a 1W resistor if current is brief)

Figure 13. Flood Gun Board Test Circuit

9-4. Check the grid voltage control as follows:

a. Switch the flood gun power switch (S3) on the System Controller OFF.

b. Connect the voltmeter between pins T (Grid) and P (Ground).

c. Switch the flood gun power switch (S3) on the System Controller ON.

d. Sweep the grid slider slowly through its range and verify that the voltages are from 0 V to 100 V, and that the system readbacks track the voltmeter. (If the readback differs from the voltmeter by more than 0.5 V, the readback should be corrected as described in part 10.)

9-5. Check the cathode voltage control as follows:

a. Switch the flood gun power switch (S3) on the System Controller OFF.

b. Connect the voltmeter to pins E or F (Cathode Voltage) and P (Ground).

c. Switch the flood gun power switch (S3) on the System Controller ON.

d. Sweep the cathode voltage slider slowly through its range and verify that the voltages are 0 V to 100 V, and that the system readbacks track the voltmeter. (If the readback differs from the voltmeter by more than 0.5 V, the readback should be corrected as described in part 10.)

Part 10. Grid and Cathode Voltage Readback Calibration

NOTE: If you replace the 1090 or 1130 board, recheck the calibrations as described below.

This procedure is a means of compensating the grid and cathode readback process so that the readbacks accurately reflect the potentials being applied to the flood gun. The technique is to introduce a numerical offset to the conversion of the 8-bit digital values that are read from the hardware registers on the flood gun controller. The conversion is normally based upon the assumption that the full range of values for each of these particular registers represents a voltage range of -100 to +100. This assumption is dictated by the values for the parameters `Rlowvalue` and `Rhighvalue` in the `Immersion / grid voltage` and `Cathode voltage` sections of the `Registers.M` file. These parameter values are normally -100 to +100, as is shown by the following segment from a `Registers.M` file:

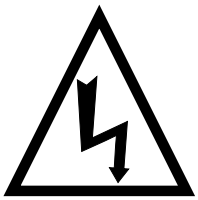
```
*Immersion / grid voltage

Wnumbits 0x00030500 12
Wlowvalue 0x00030500   0.0
Whighvalue 0x00030500   100.0
Wsoftlow 0x00030500   0.0
Wsofthigh 0x00030500   100.0
Rnumbits 0x00030500      8
Rlowvalue 0x00030500   -100.0
Rhighvalue 0x00030500   100.0
```

To introduce the offset, edit the `Registers.M` file (using the *vi* editor) to change the range specified by these parameter values. If you make the range specification smaller, for example, -99 to 99, the effective value of the LSB in the hardware register decreases, which translates to a numerically lower readback for a given voltage.

With the Electron Flood Gun control popup displayed, the system in ion imaging mode, and the flood gun unblanked, proceed as follows.

WARNING



Electrical potentials as high as 500 volts may be present at the J1801 connector when the flood gun power switch (S3) on the System Controller is in the ON position. When making the voltage measurements described below, be sure to switch the flood gun power switch OFF before connecting or disconnecting the voltmeter probes.

10-1. Calibrate the grid voltage readback as follows:

a. Switch the flood gun power switch (S3) on the System Controller OFF.

b. With J1801 unplugged from the feedthrough connector (as in part 9 above), connect the voltmeter between pins T (Grid) and P (Ground).

c. Switch the SysCon flood gun power switch (S3) ON, and note the voltmeter reading.

d. Use *vi* to adjust the values for `Rlowvalue` and `Rhighvalue` in the grid voltage section of the `Registers.M` file by one volt. For example, if the readback reads high (which is often the case with the grid voltage readback), reduce the values to –99.0 and 99 respectively.

e. Restart the Microsurgery program to cause the change to be recognized.

f. Compare the readback with the voltmeter reading and repeat substeps *d* and *e* as necessary until the readback is within 0.5V of the meter.

10-2. Calibrate the cathode voltage readback as follows:

a. Switch the flood gun power switch (S3) on the System Controller OFF.

b. Connect the voltmeter between pins E or F (Cathode Voltage) and P (Ground).

c. Switch the flood gun power switch (S3) on the System Controller ON, and note the voltmeter reading.

d. Use *vi* to adjust the values for `Rlowvalue` and `Rhighvalue` in the cathode voltage section of the `Registers.M` file by one volt. For example, if the readback reads low (which is often the case with the cathode readback), increase the values to –101.0 and 101 respectively.

e. Restart the Microsurgery program to cause the change to be recognized.

f. Compare the readback with the voltmeter reading and repeat substeps *d* and *e* as necessary until the readback is within 0.5V of the meter.

Part 11. Problem Diagnosis

General

The following section may help with diagnosing some of the more common flood gun problems. Listed below are typical operating parameters.

Cathode V: –85
Grid V: –83
Deflection V: 1 to 5 (5 would be worst case)
Filament I: 1.3 to 1.6 A (depending on gun type, age, and gas exposure).

With the system up and imaging, go to the electron faraday and center it in the field of view. Open the Electron Flood Gun Control popup (Misc menu). Try optimizing the flood gun by using the automatic calibration function (click on the Calibrate button in the Electron Flood Gun Control popup). Note any anomalies so you know where to proceed next.

If you have a picoammeter, connect it to the *EFAR* BNC on the work chamber. If you only have a voltmeter, hook it up to the *EFAR* BNC on the work chamber using the dual banana-to-BNC and a coax cable. Set the voltmeter to the mV scale. With a 10 Mohm input impedance you will see 10 mV/nA in the cup. Use this as a real-time current monitor.

Symptom: Unstable Output

Manually sweep the deflection voltage slowly using the small arrows in the popup. (A 0.1 V change on the deflection can have a big effect). Watch the meter to see if the electron faraday cup current changes significantly.

If you see that the faraday cup current gets larger, but then decreases steadily over a period of minutes or oscillates slowly, something may be charging and either deflecting or suppressing the E-gun output.

If the decrease is steady and does not return to the original value, try varying the screen or deflection voltages. If changing these potentials brings the beam back, the beam is being deflected. Possible causes of this are:

- Deposits on the electron faraday aperture (which should be cleaned about every month or whenever the gun is changed), MCP, E-Gun aperture, or deflectors
- Contamination in the gun

Symptom: Decreased Output (E-Gun aging)

Sometimes the gun life can be extended by increasing the grid voltage and readjusting the deflection.

Increase or decrease the grid voltage if the gun seems to be running out of electrons. If you find a non-standard setting that works well, change Egun.M to include this setting.

Micron

Service Procedure No.: **05-04-10**
Service Procedure Title: **Flood Gun Removal and Replacement: 10 nm Column**
Applicable Systems: **8000, Micrion 9800 FlipChip, MicroMill HT**
Frequency of Service: **As needed**

Introduction

The electron flood gun (also called the E-Gun) provides charge neutralization of the sample. The flood gun voltage is supplied by the flood gun supply board (150-001130) and is controlled by the flood gun interface board (150-001090).

Materials and Tools Required

- Tie-wrap (a.k.a. Spot-tie)
- Voltmeter with at least 10 Megohm input impedance.
- Picoammeter (Optional).
- BNC - Dual Banana Adapter.
- Clip leads.
- 6 foot coax cable.
- E-Gun Board Test Circuit
- Schematic 163-00342X (E-Gun Harness)
- Clean, standard field service tool kit

This procedure uses diagnostic methods published in Tech Note 002, “Flood Gun Diagnostics.”

NOTICE

Per paragraph 11.1 of *Safety Guidelines for Semiconductor Manufacturing Equipment* (S2-93), this procedure is a Type 5 task. Specifically: “Equipment is energized and measurements and adjustments require physical entry into the equipment, or equipment configuration will not allow the use of clamp-on probes.”

Installation Pre-Check

Prior to the installation, visually check that the flood gun and the snout bore are free from contamination. Also perform the continuity checks to ensure that the filament is not open and none of the snout elements are shorted.

Part 1. System Preparation

Configure the Chemical Sources in "Safe" Mode

Before performing the tasks described in this procedure, you must put the chemical sources in a "safe" mode; see Service Procedure 02-01.

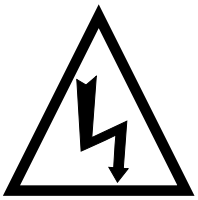
WARNING

Do not proceed until the chemical sources are secure. The chemical reservoirs in FIB systems contain hazardous materials. Labels affixed to the exterior of a chemical cabinet identify the chemical(s) contained inside. If a chemical source is not in its "safest" state, as described in **Service Procedure 02-01**, it is possible for a combination of component failures to release the chemical(s) through a cabinet's delivery line, a roughing line, a purging line, or from a chemical reservoir into the workchamber. Do not open the workchamber, or disassemble any part of the vacuum pumping system, or detach any gas line from any chemical cabinet until you are sure that every chemical source attached to the FIB system is in its "safest" state.

Power Down and Vent the System

Before performing the tasks described in this procedure, you must power down and vent the system; see Service Procedure 01-02.

WARNING



Dangerously high voltages are present in the process module while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and automatic procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

Clean off the exterior of the system as well as the floor; see Service Procedure 06-05.

Open the Workchamber

Remove the front panels to gain access to the workchamber door.

Once the system is completely vented, open the workchamber door by removing the 1/2" socket head cap screws.

Part 2. Remove the Flood Gun

2-1. After the system has vented, open the workchamber. Two types of flood gun/MCP configurations are installed in FIB systems with 10 nm columns: a flood gun without a snout combined with a small MCP (as shown in Figures 1 and 2), and a flood gun with a snout paired with a large MCP[1] (as shown in Figures 3, 4, and 5).

2-2. Remove the flood gun electrical connectors: disconnect the grid lead, the two filament leads, and the 4-pin keyed connector (see Figures 1, 3, and 4).

NOTICE: DO NOT DROP MOUNTING SCREWS

Before removing and replacing the flood gun, place a clean lint-free wipe below the flood gun to prevent the mounting screws from falling into the turbo pump or the stage hardware. **If a screw is dropped into the workchamber, be sure to retrieve it before proceeding.**

2-3. Remove the flood gun from the workchamber lid by removing the two mounting screws as shown in Figures 3 and 4. Be careful not to damage the MCP screen.

[1] There are two configurations of the flood gun with a snout and large MCP combination (see Figures 3 and 4). In a 9800 series system (as shown in Figure 4), the flood gun is rotated 90° to accommodate the installation of an optical microscope.

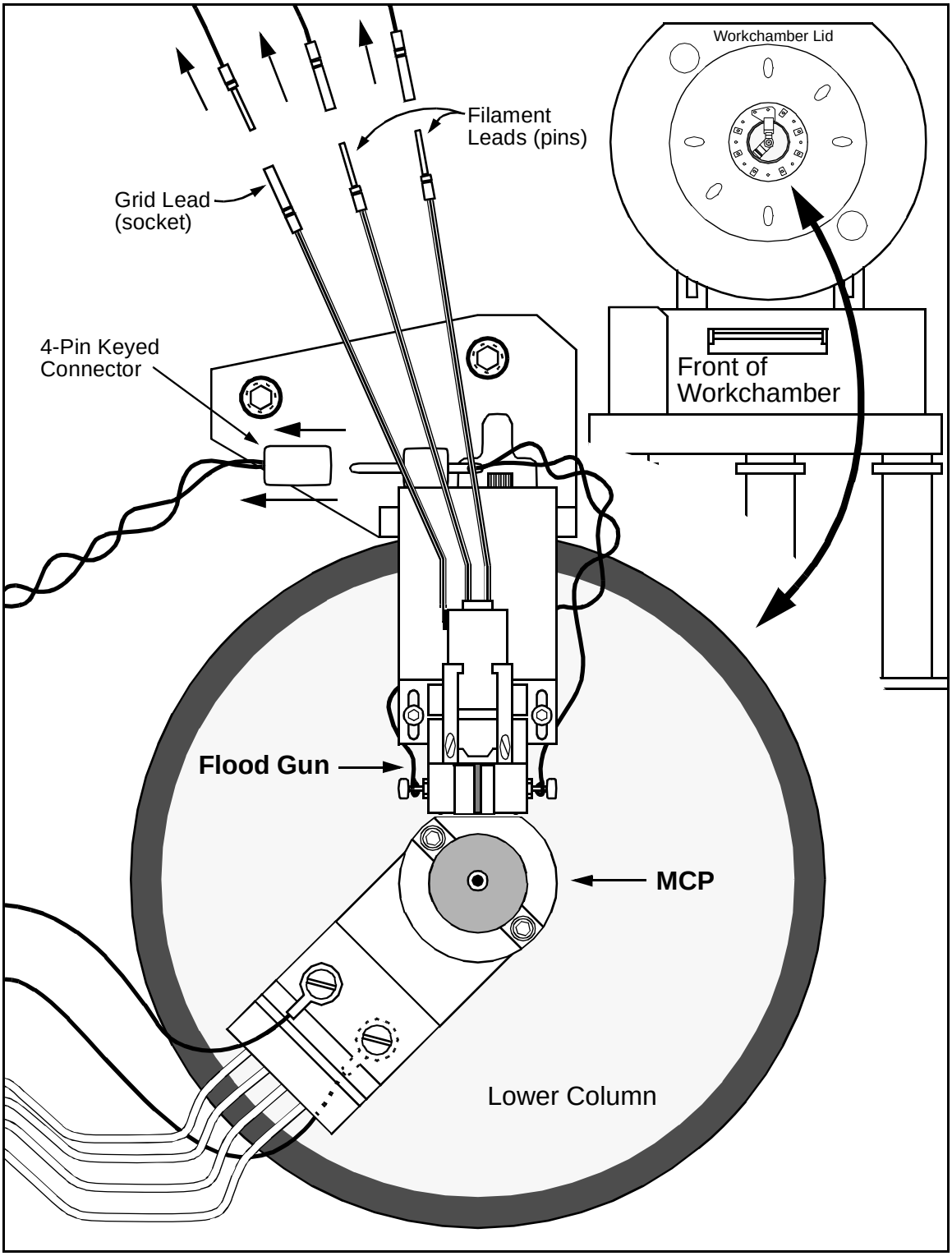


Figure 1. Flood Gun Without Snout and Small MCP: Interior View

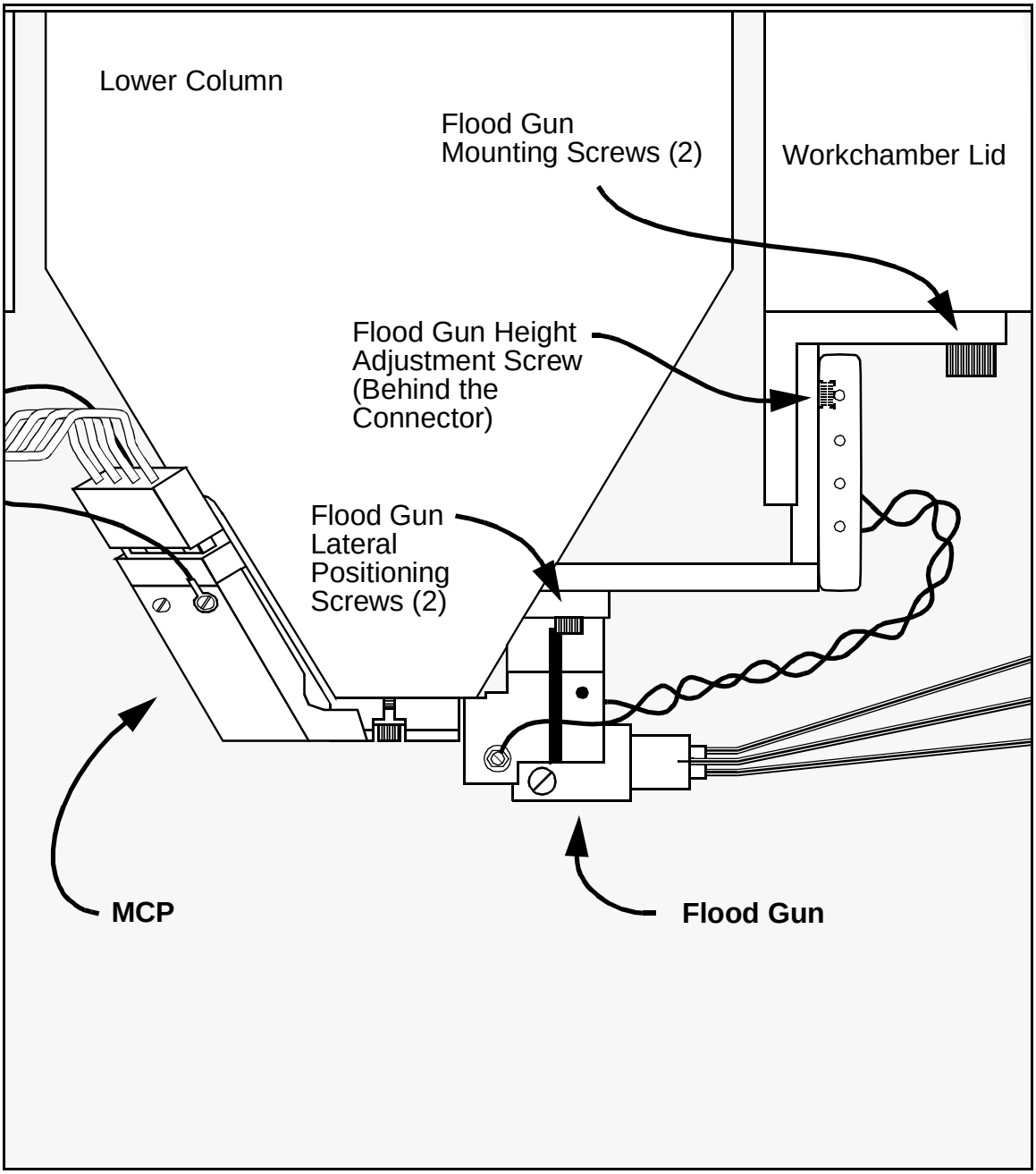


Figure 2. Side View of Flood Gun Without Snout and Small MCP(s)

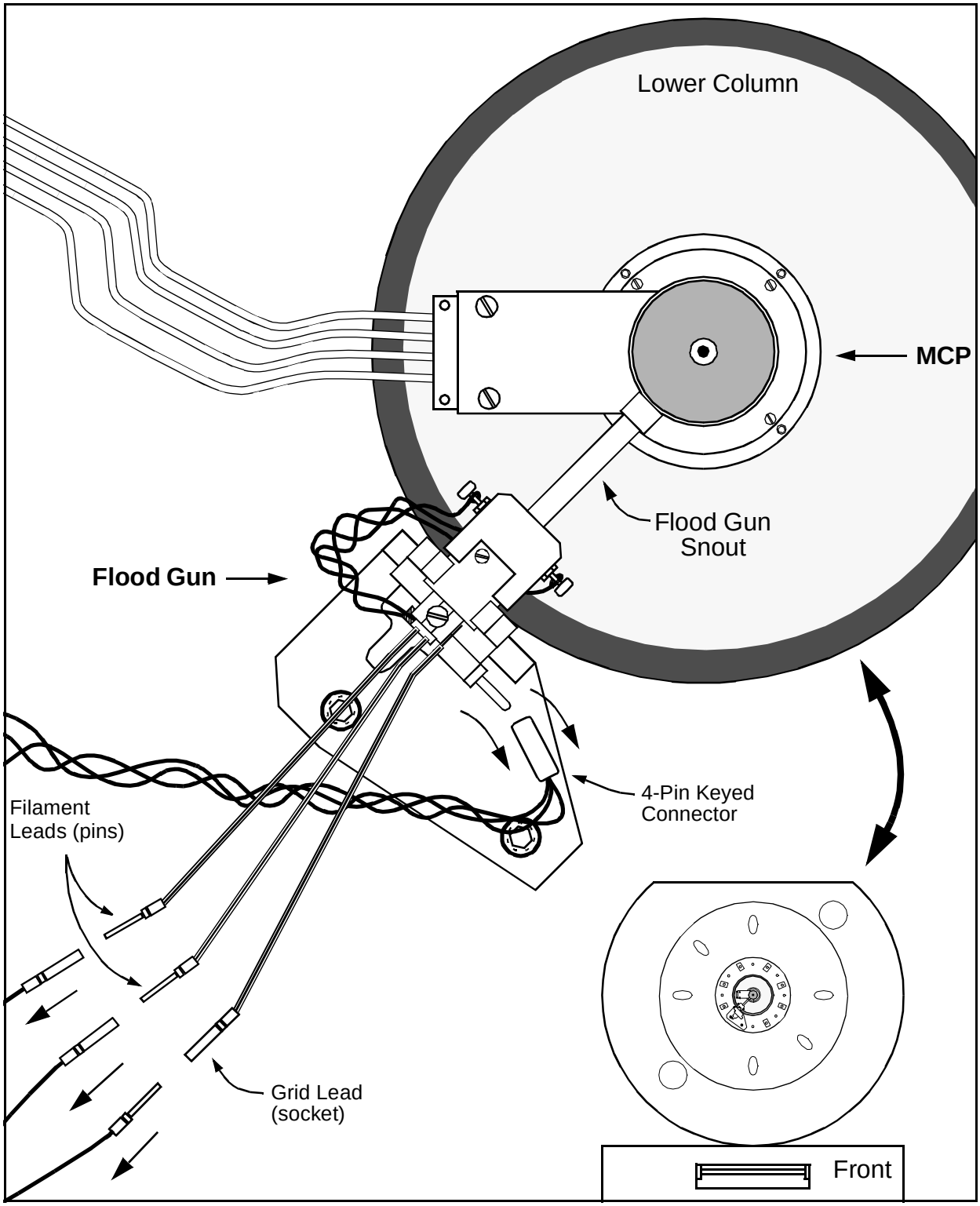


Figure 3. Flood Gun With Snout and Large MCP: Interior View

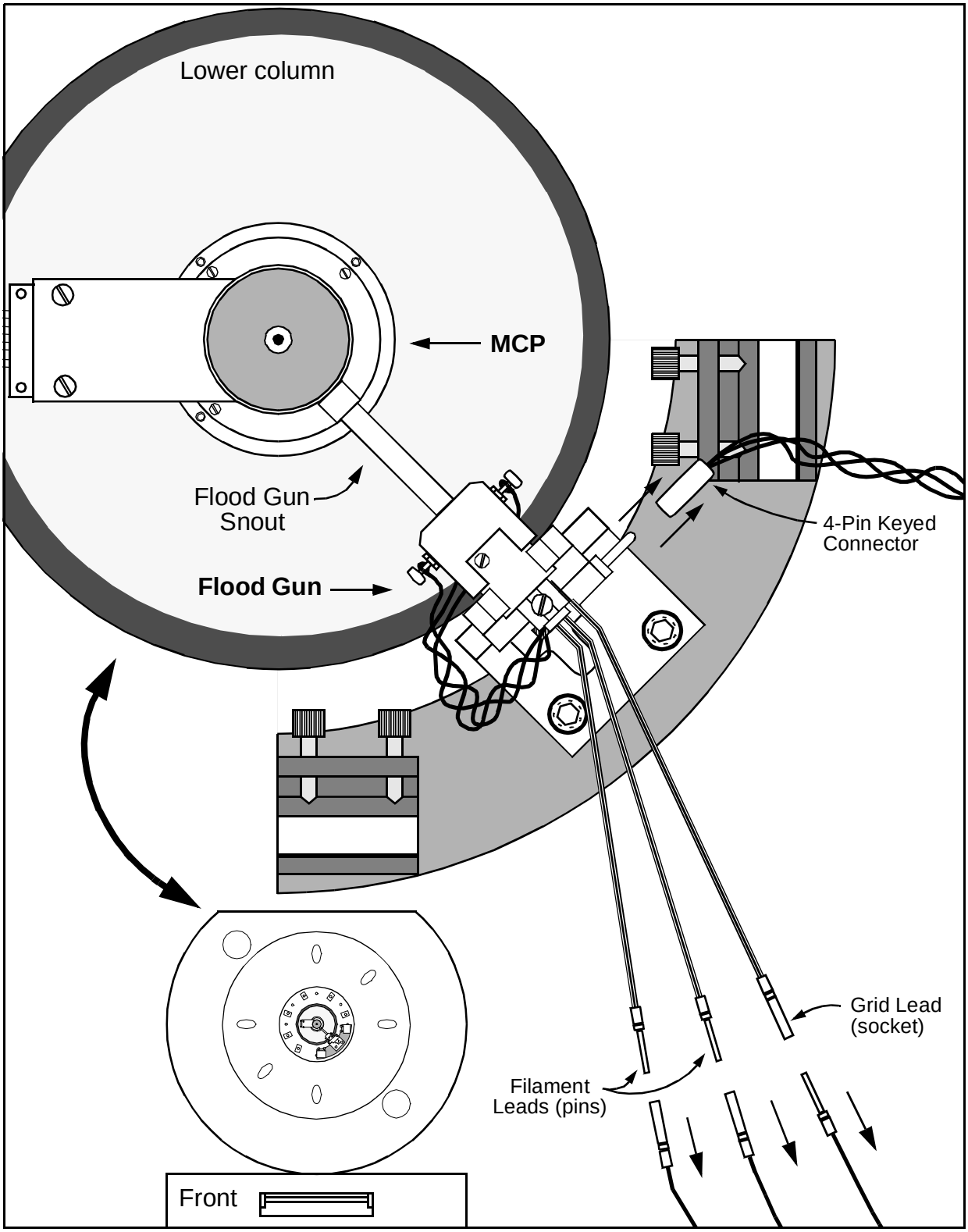


Figure 4. Flood Gun With Snout and Large MCP in 9800 System: Interior View

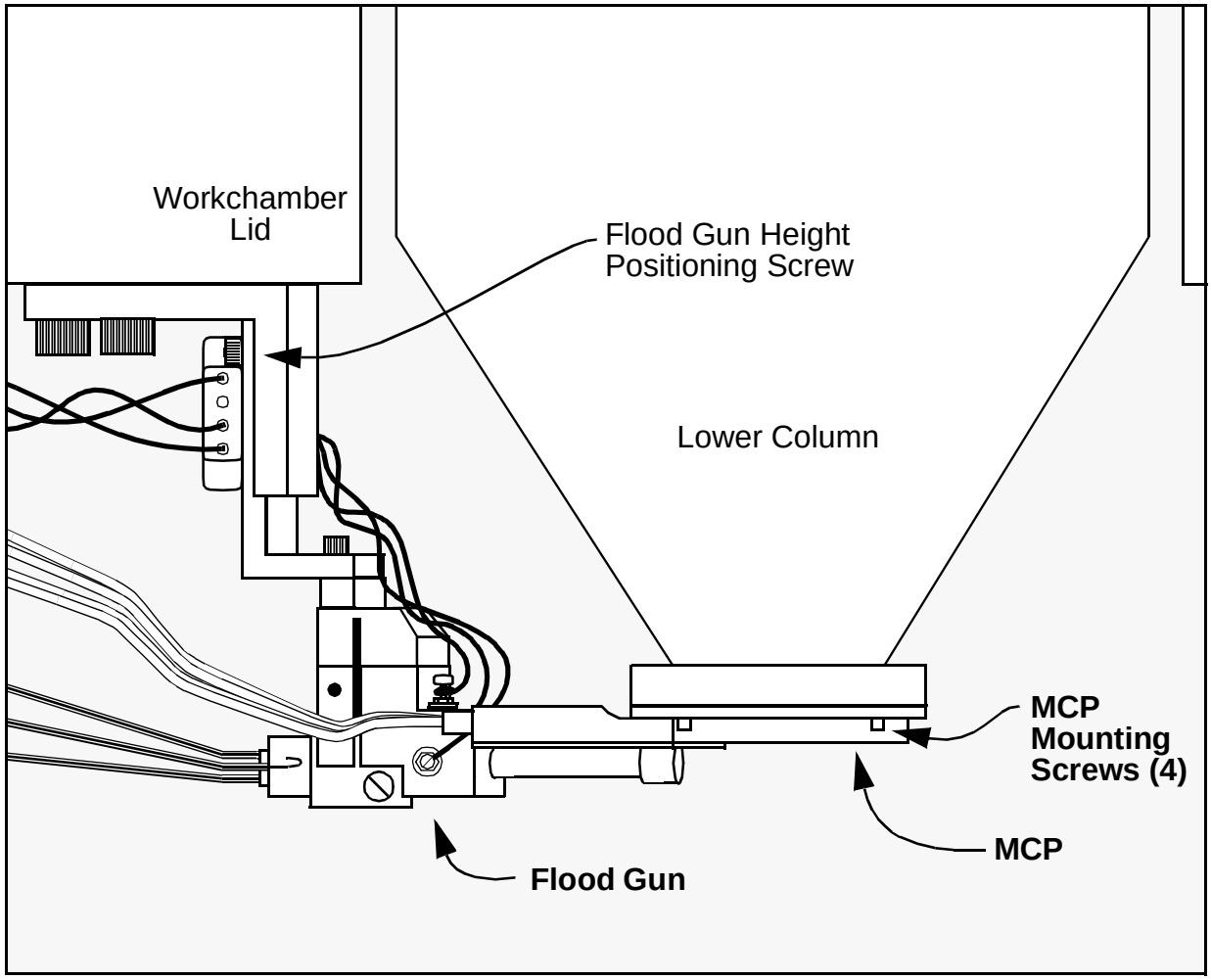


Figure 5. Side View of Flood Gun With Snout and Large MCP

Part 3. Inspect and Test the Replacement Flood Gun

NOTICE: THE FLOOD GUN AND ITS COMPONENTS ARE FRAGILE

Handle the flood gun with care. The flood gun leads are somewhat brittle and will break if they are bent back and forth excessively.

3-1. Remove the shipping screw (see Figures 6 and 7).

3-2. Loosen the height adjustment screw. Slide the upper bracket as far away from the lower flood gun as the height adjustment screw allows, then tighten the height adjustment screw (see Figures 6 and 7).

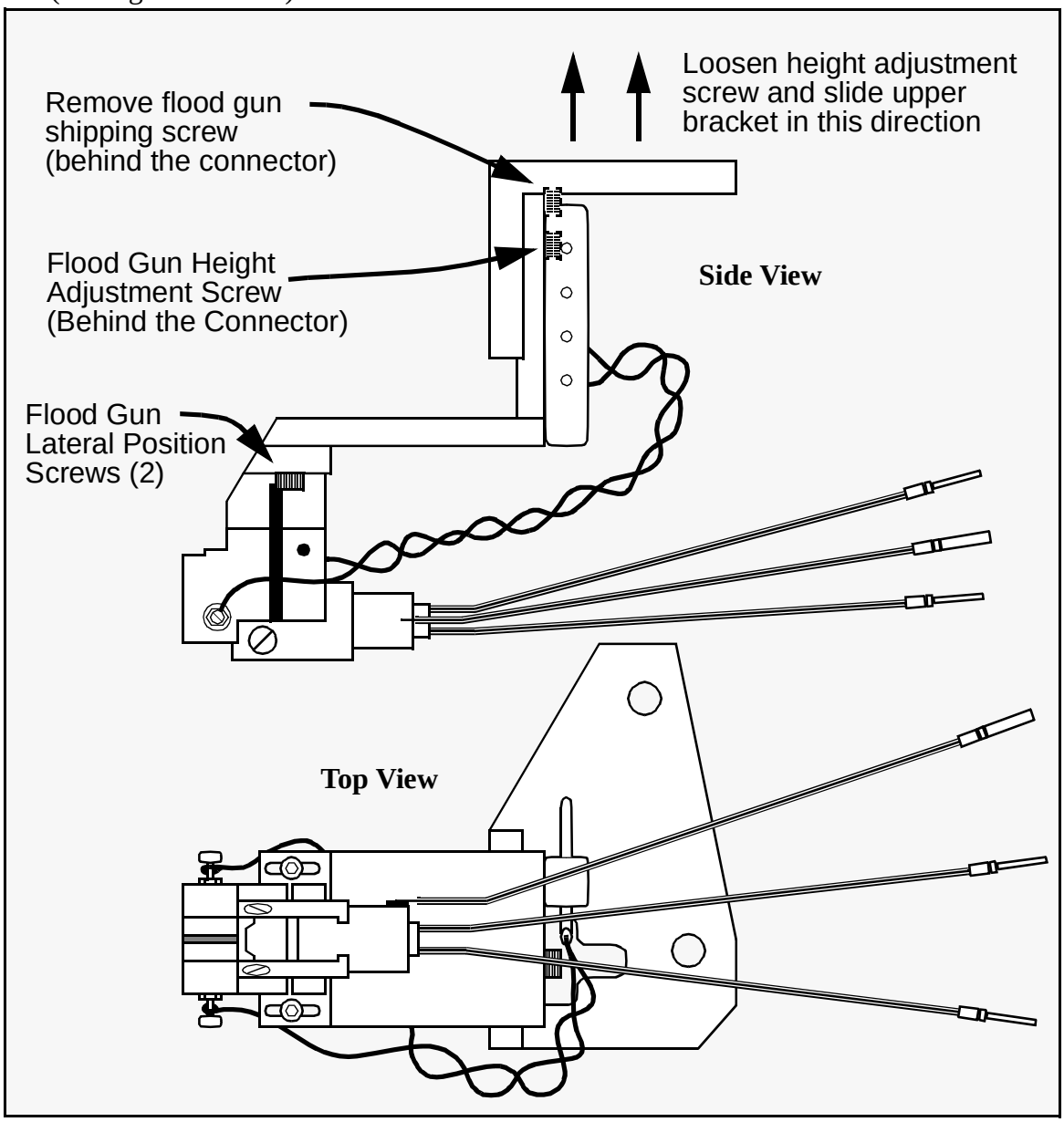

Loosen height adjustment screw and slide upper bracket in this direction
Remove flood gun shipping screw (behind the connector)
Flood Gun Height Adjustment Screw (Behind the Connector)
Side View
Flood Gun Lateral Position Screws (2)
Top View

Figure 6. Replacement Flood Gun Without Snout: Side and Top Views

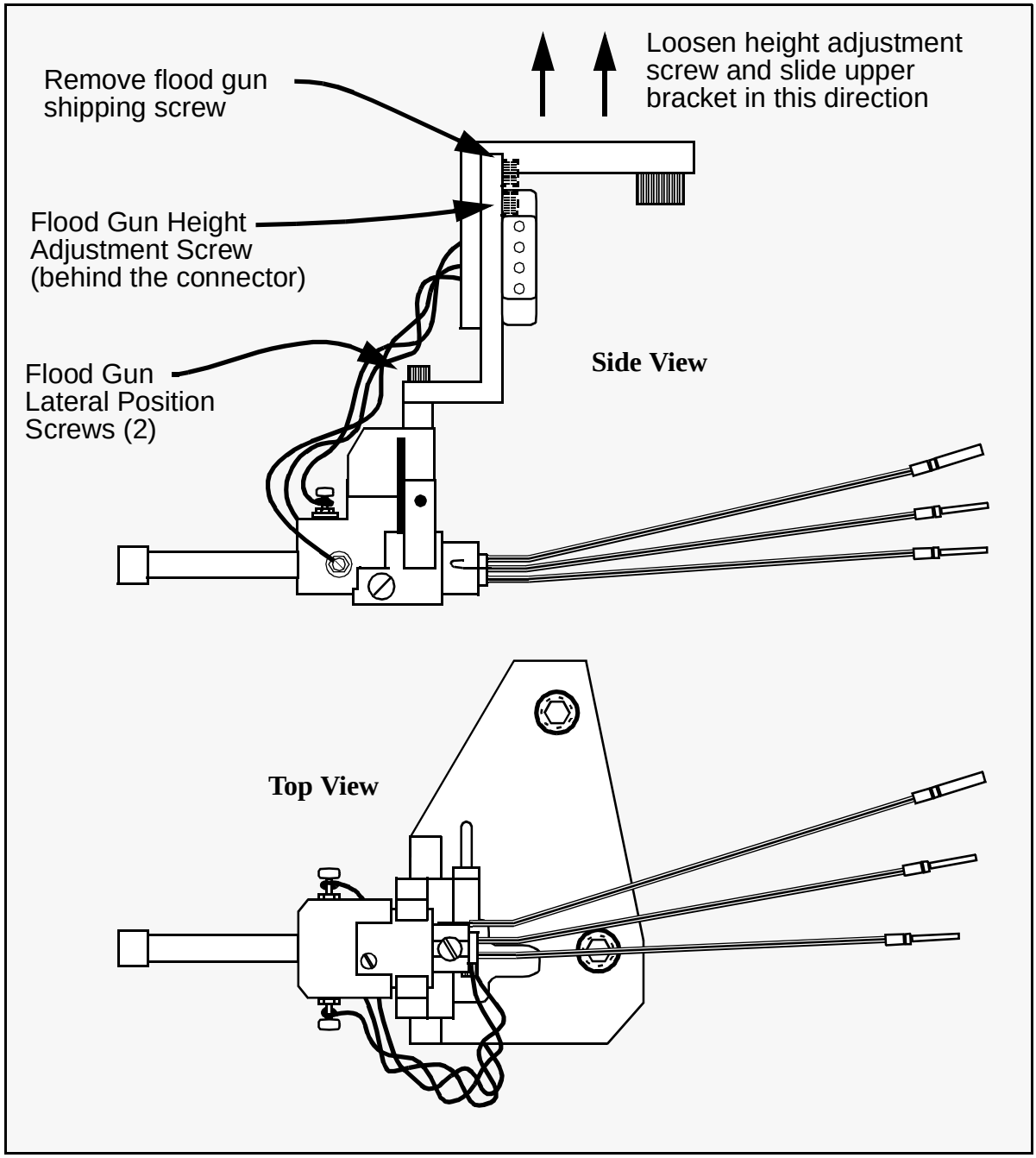

Loosen height adjustment screw and slide upper bracket in this direction
Remove flood gun shipping screw
Flood Gun Height Adjustment Screw (behind the connector)
Flood Gun Lateral Position Screws (2)
Side View
Top View

Figure 7. Replacement Flood Gun With Snout: Side and Top Views

3-3. Continuity Tests:

a. To test a flood gun without a snout, use an ohmmeter to perform the continuity tests listed in Table 1. The test measurement points are shown in Figure 8. If the measurements do not match those in Table 1, contact Micrion Customer Support.

b. To test a flood gun with a snout, use an ohmmeter to perform the continuity tests listed in Table 2. The test measurement points are shown in Figure 9. If the measurements do not match those in Table 2, contact Micrion Customer Support.

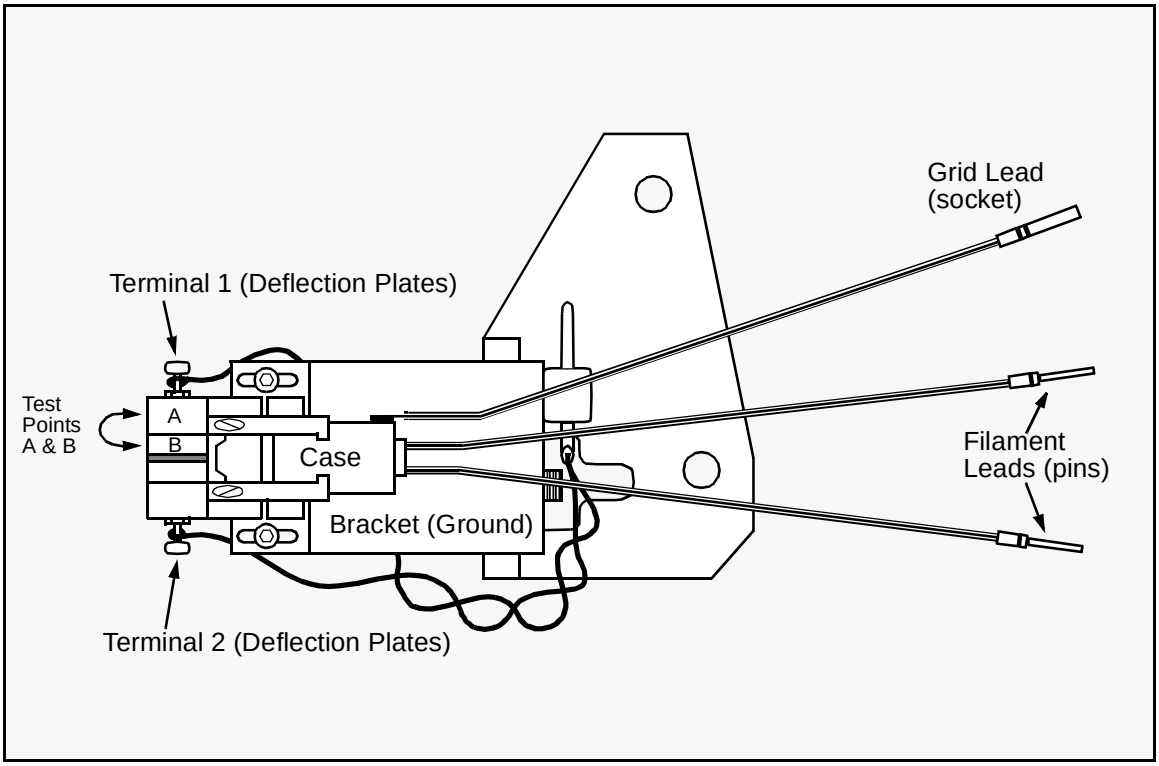


Figure 8. Flood Gun Without Snout: Continuity Test Points

Table 1: Flood Gun Without Snout: Continuity Tests

From	To	Continuity
Point A	Point B	Not Continuous
Filament Lead 1	Filament Lead 2	Continuous
Filament Lead (either)	Ground	Not Continuous
Filament Lead (either)	Grid Lead	Not Continuous
Terminal 1	Ground	Not Continuous
Terminal 2	Ground	Not Continuous
Case	Ground	Not Continuous

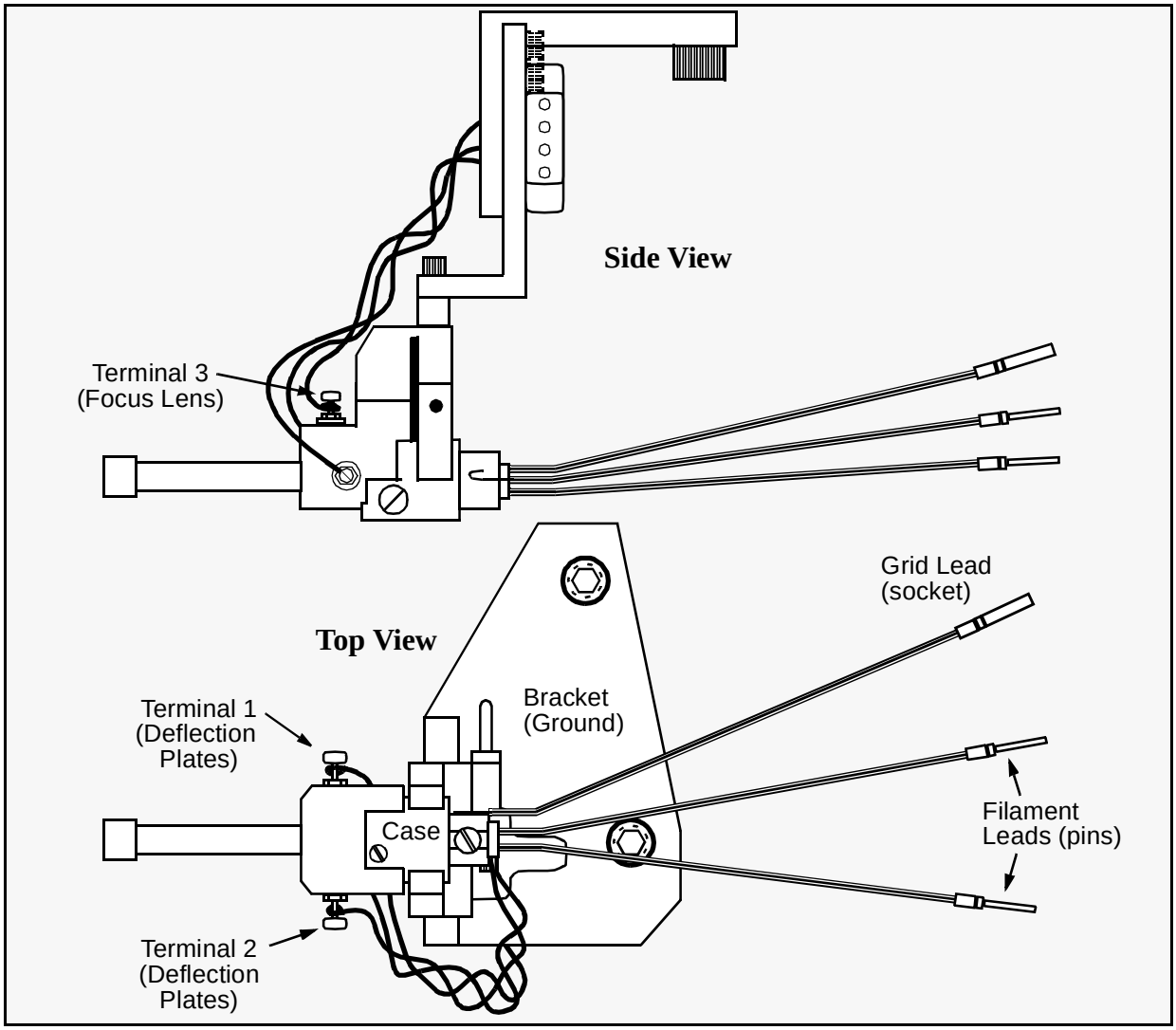


Figure 9. Flood Gun With Snout: Continuity Test Points

Table 2: Flood Gun With Snout: Continuity Tests

From	To	Continuity
Filament Lead 1	Filament Lead 2	Continuous
Filament Lead (either)	Ground	Not Continuous
Filament Lead (either)	Grid Lead	Not Continuous
Terminal 1	Ground	Not Continuous
Terminal 2	Ground	Not Continuous
Terminal 3	Terminals 1 & 2	Not Continuous
Case	Ground	Not Continuous

Part 4. Install the Replacement Flood Gun

4-1. Fasten the flood gun assembly to the Workchamber Lid with the mounting screws (see Figures 10 and 11).

4-2. Flood gun adjustment (be careful not to damage the MCP screen during the adjustment):

a. To adjust a flood gun without a snout, loosen the height adjustment screw and slide the flood gun up until the lower portion of the flood gun assembly contacts (is flush against) the lower column cover (see Figures 1, 2 and 10). Make sure that the flood gun is aligned with (points directly at) the center bore of the MCP (see Figure 1). If necessary, loosen the lateral positioning screws and adjust the lateral position of the flood gun to obtain a good fit against the lower column cover.

b. To adjust a flood gun with a snout, loosen the height adjustment screw and slide the flood gun up until the end of the flood gun snout contacts the MCP as shown in Figures 3, 4, 5, and 11. Be careful not to damage the MCP screen. Make sure that the flood gun snout is aligned with (points directly at) the center bore of the MCP (see Figures 1 and 2). If necessary, loosen the lateral positioning screws and adjust the lateral position of the flood gun to obtain the proper orientation against the MCP (see Figure 6).

4-3. Tighten the height (and, if used, the lateral) adjustment screw(s).

4-4. Reattach the flood gun electrical connections as shown in Figures 1, 3, and 4.

4-5. Clean the interior of the system as described in Service Procedure 06-03.

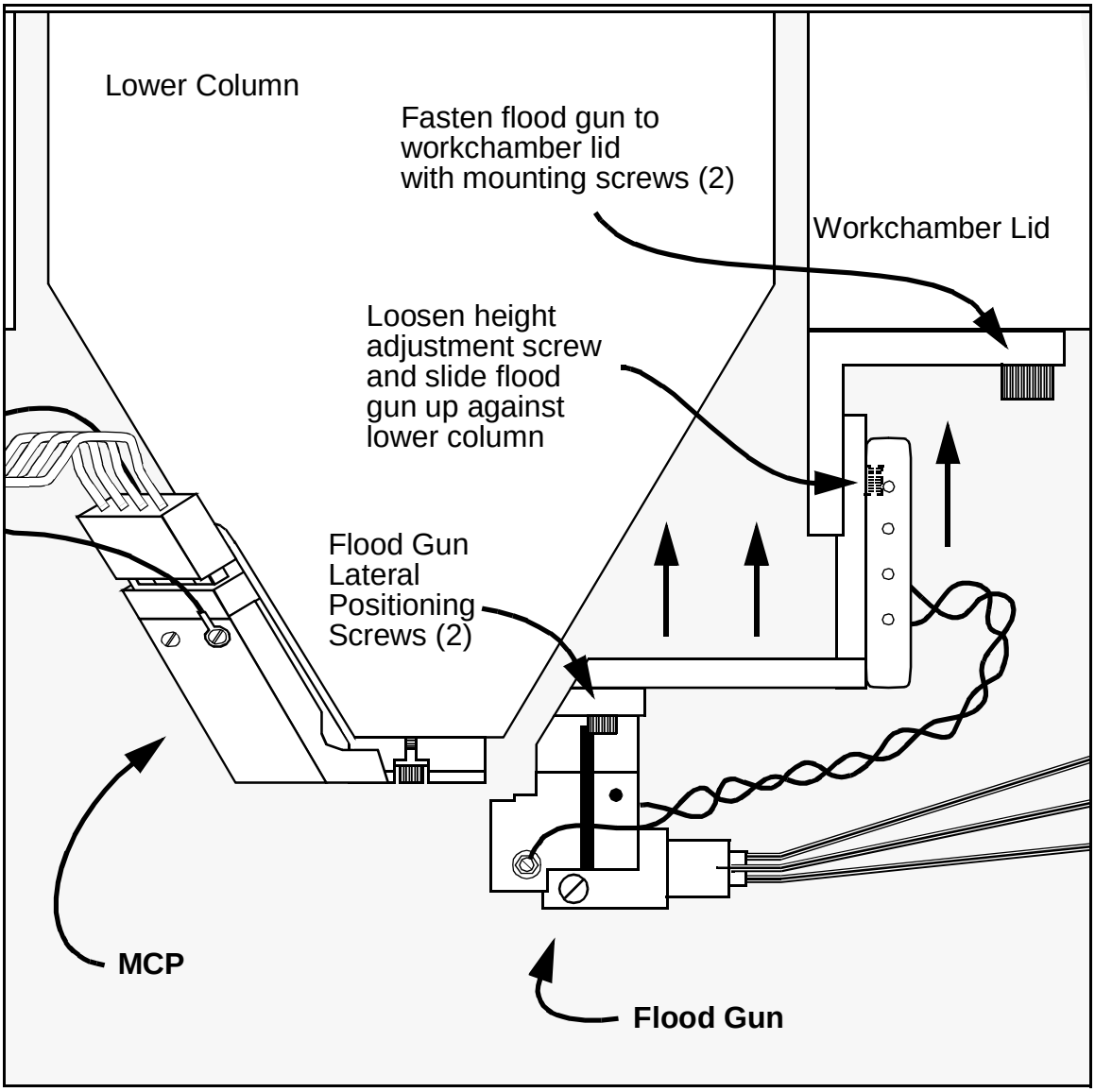

Lower Column
Fasten flood gun to workchamber lid with mounting screws (2)
Workchamber Lid
Loosen height adjustment screw and slide flood gun up against lower column
Flood Gun Lateral Positioning Screws (2)
MCP
Flood Gun

Figure 10. Installation of Replacement Flood Gun Without Snout

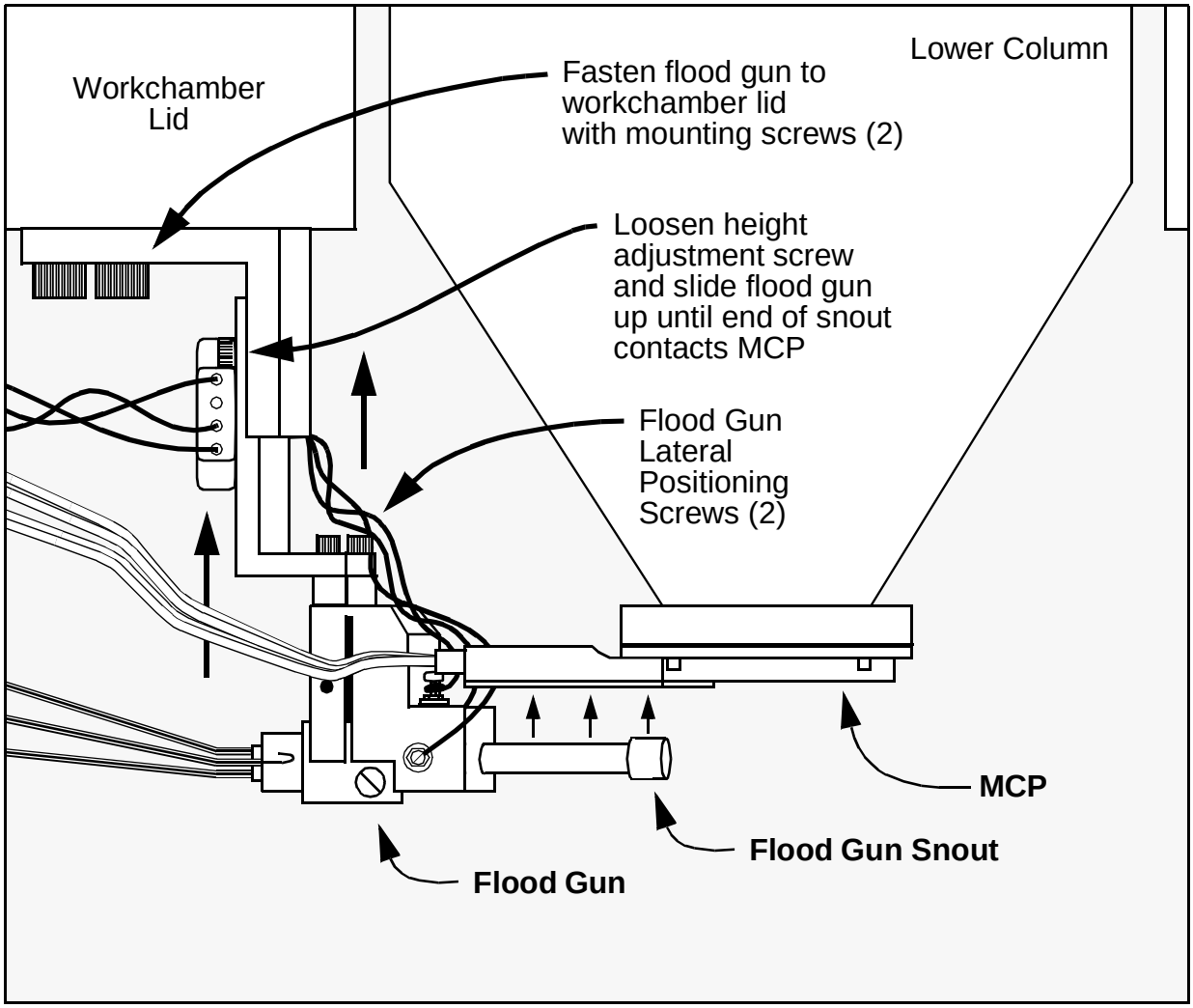

Lower Column
Workchamber Lid
Fasten flood gun to workchamber lid with mounting screws (2)
Loosen height adjustment screw and slide flood gun up until end of snout contacts MCP
Flood Gun Lateral Positioning Screws (2)
MCP
Flood Gun Snout
Flood Gun

Figure 11. Installation of Replacement Flood Gun With Snout

Part 5. Power Up and Beam Up

Follow Service Procedure 01-01 to power up and bring the beam up.

Part 6. Flood Gun Control/Calibration

The Electron Flood Gun popup provides access to an automated calibration function and allows manual control of the potentials applied to the flood gun elements. This popup is accessible either through the Microsurgery program's Misc menu (select *E-Gun Control*), or through the Beam Screen (click on the flood gun graphic located to the immediate right of the image area).

An automatic calibration function is available through the Electron Flood Gun popup. To use it, make sure that the system is in ion imaging mode, and then click on the *Calibrate* button in the popup. The calibration function brings the electron faraday under the column, sweeps the various flood gun control potentials to obtain optimum current in the faraday, and then returns the stage to its former position.

To obtain popups for manually changing the potentials applied to the flood gun elements, click on the graphical representations of the elements in the Electron Flood Gun popup. For manual intervention, you must disable the flood gun maintenance software function (with the *Maintenance* button in the Electron Flood Gun popup), which monitors and adjusts the filament current to maintain constant emission (cathode current).

Part 7. Checking the Flood Gun Boards (150-001130/150-001090).

7-1. If the system is currently up, perform an Auto power down and switch off the System Controller Chassis, as explained in Service Procedure 01-02.

7-2. Remove all external connections from the 150-001130 board. (See Service Procedure 12-11, Flood Gun Supply Board, for connectors.)

7-3. Remove the 150-001130 board from its slot, place it on an extender card, and put the extender in the slot.

7-4. Switch on the System Controller Chassis. (See Service Procedure 01-01.)

7-5. Referring to Service Procedure 12-12, verify that all the proper supply voltages are present on the board.

7-6. Switch off the System Controller Chassis and return the 150-001130 board to its slot.

7-7. Repeat steps 7-2 through 7-6 for the 150-001090 board. (See Service Procedure 12-11, Flood Gun Interface Board.)

7-8. Reconnect all external connections to the 150-001130 and 150-001090 boards.

7-9. Switch on the System Controller Chassis.

7-10. Switch on the Computer and wait for the bootstrap to complete.

7-11. When prompted, log in as *micrion*.

Part 8. E-Gun Resistance Checks

8-1. In the flood gun control popup:

a. Click on the filament graphic to obtain the filament control popup, and manually slide the filament control to any value and then back to ZERO.

b. Set the remaining sliders to the following values:

Grid - 0, Focus - 0, Cathode - 0, Deflection - 0, Screen - 0.

8-2. Remove the cable from connector J1801 on the E-Gun feedthrough port. Connector J1801 and the E-Gun feedthrough port are located on the right side (looking from the front of the system) of the workchamber lid. The harness number on the label should be 160-003422.

8-3. Check the connector pins on the feedthrough port (the wire harness between the feedthrough and the flood gun; not the harness between the System Controller and the feedthrough) as follows:

a. Check between pins E, F (filament), you should have continuity. If not, the E-gun filament or internal harness is open.

b. Check between pins U, G, and H (Focus lens to Deflection plates). They should be open.

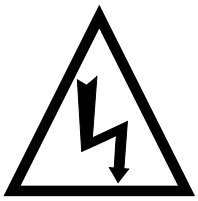
c. Check between pins T and E or F (Filament and Grid elements). They should be open.

d. Check E, F, G, H, T and U to ground. They should all be open.

Part 9. E-Gun Assembly Voltage Checks

For the following steps, use the control sliders in the popups for the focus and deflection elements. Change the slider settings and watch how both the measured (metered) and system readback voltages vary. Make sure that changes are smooth and linear over the entire slider range. If there are large jumps or other erratic behavior, a DAC, ADC or power supply may be failing. Please note the following hazard warning and take the safety precautions prescribed.

WARNING



Electrical potentials as high as 500 volts may be present at the J1801 connector when the flood gun power switch (S3) on the System Controller is in the ON position. When taking the voltage measurements described below, be sure to switch the flood gun power switch OFF before connecting or disconnecting the voltmeter probes.

9-1. Check the positive deflection voltage control as follows:

a. Switch the flood gun power switch (S3) on the System Controller OFF.

b. Connect the voltmeter between pins G (Ydef+) and P (Ground).

c. Switch the flood gun power switch (S3) on the System Controller ON.

d. Sweep the deflection slider slowly through its range and verify that the positive voltage is the same magnitude as the negative voltage (0 V to +/- 10 V), and that the readbacks track the voltmeter.

9-2. Check the negative deflection voltage control as follows:

a. Switch the flood gun power switch (S3) on the System Controller OFF.

b. Connect the voltmeter between pins H (Ydef-) and P (Ground). NOTE: This will be opposite in polarity to pin G above.

c. Switch the flood gun power switch (S3) on the System Controller ON.

d. Sweep the deflection slider slowly through its range and verify that the negative voltage is the same magnitude as the positive voltage (0 V to +/- 10 V), and that the readbacks track the voltmeter.

9-3. Check the filament voltage control as follows:

a. Make sure that the system is in ion imaging mode and that the flood gun is unblanked.

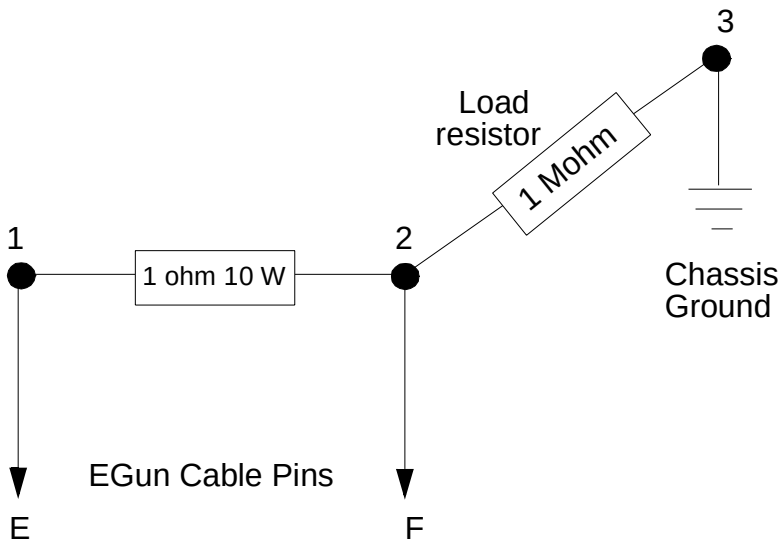
a. Switch the flood gun power switch (S3) on the System Controller OFF.

b. Connect the “Flood Gun Board Test Circuit” to pins E and F (Filament supply) of the cable connector and connect point 3 to chassis ground with a clip lead (see Fig. 6).

c. Switch the flood gun power switch (S3) on the System Controller ON.

d. Sweep the filament slider slowly through its range. Verify that the proper voltages are present and that the system readbacks track the voltmeter.

e. Disconnect the “Flood Gun Board Test Circuit”.



Point 1 to Point 2: Filament Current (I=E/R), which calculates to what is on the slider.
Point 2 to Ground: Cathode Voltage (CATV)
CATC readback on the beam control screen should equal CATV/ 1 Mohm
(If no 10W resistor is available, you can use a 1W resistor if current is brief)

Figure 12. Flood Gun Board Test Circuit

9-4. Check the grid voltage control as follows:

a. Switch the flood gun power switch (S3) on the System Controller OFF.

b. Connect the voltmeter between pins T (Grid) and P (Ground).

c. Switch the flood gun power switch (S3) on the System Controller ON.

d. Sweep the grid slider slowly through its range and verify that the voltages are from 0 V to 100 V, and that the system readbacks track the voltmeter. (If the readback differs from the voltmeter by more than 0.5 V, the readback should be corrected as described in part 10.)

9-5. Check the cathode voltage control as follows:

a. Switch the flood gun power switch (S3) on the System Controller OFF.

b. Connect the voltmeter to pins E or F (Cathode Voltage) and P (Ground).

c. Switch the flood gun power switch (S3) on the System Controller ON.

d. Sweep the cathode voltage slider slowly through its range and verify that the voltages are 0 V to 100 V, and that the system readbacks track the voltmeter. (If the readback differs from the voltmeter by more than 0.5 V, the readback should be corrected as described in part 10.)

Part 10. Grid and Cathode Voltage Readback Calibration

NOTE: If you replace the 1090 or 1130 board, recheck the calibrations as described below.

This procedure is a means of compensating the grid and cathode readback process so that the readbacks accurately reflect the potentials being applied to the flood gun. The technique is to introduce a numerical offset to the conversion of the 8-bit digital values that are read from the hardware registers on the flood gun controller. The conversion is normally based upon the assumption that the full range of values for each of these particular registers represents a voltage range of -100 to +100. This assumption is dictated by the values for the parameters `Rlowvalue` and `Rhighvalue` in the `Immersion / grid voltage` and `Cathode voltage` sections of the `Registers.M` file. These parameter values are normally -100 to +100, as is shown by the following segment from a `Registers.M` file:

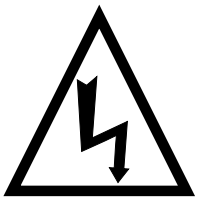
```
*Immersion / grid voltage

Wnumbits 0x00030500 12
Wlowvalue 0x00030500   0.0
Whighvalue 0x00030500   100.0
Wsoftlow 0x00030500   0.0
Wsofthigh 0x00030500   100.0
Rnumbits 0x00030500      8
Rlowvalue 0x00030500   -100.0
Rhighvalue 0x00030500   100.0
```

To introduce the offset, edit the `Registers.M` file (using the *vi* editor) to change the range specified by these parameter values. If you make the range specification smaller, for example, -99 to 99, the effective value of the LSB in the hardware register decreases, which translates to a numerically lower readback for a given voltage.

With the Electron Flood Gun control popup displayed, the system in ion imaging mode, and the flood gun unblanked, proceed as follows.

WARNING



Electrical potentials as high as 500 volts may be present at the J1801 connector when the flood gun power switch (S3) on the System Controller is in the ON position. When making the voltage measurements described below, be sure to switch the flood gun power switch OFF before connecting or disconnecting the voltmeter probes.

10-1. Calibrate the grid voltage readback as follows:

a. Switch the flood gun power switch (S3) on the System Controller OFF.

b. With J1801 unplugged from the feedthrough connector (as in part 9 above), connect the voltmeter between pins T (Grid) and P (Ground).

c. Switch the SysCon flood gun power switch (S3) ON, and note the voltmeter reading.

d. Use *vi* to adjust the values for `Rlowvalue` and `Rhighvalue` in the grid voltage section of the `Registers.M` file by one volt. For example, if the readback reads high (which is often the case with the grid voltage readback), reduce the values to –99.0 and 99 respectively.

e. Restart the Microsurgery program to cause the change to be recognized.

f. Compare the readback with the voltmeter reading and repeat substeps *d* and *e* as necessary until the readback is within 0.5V of the meter.

10-2. Calibrate the cathode voltage readback as follows:

a. Switch the flood gun power switch (S3) on the System Controller OFF.

b. Connect the voltmeter between pins E or F (Cathode Voltage) and P (Ground).

c. Switch the flood gun power switch (S3) on the System Controller ON, and note the voltmeter reading.

d. Use *vi* to adjust the values for `Rlowvalue` and `Rhighvalue` in the cathode voltage section of the `Registers.M` file by one volt. For example, if the readback reads low (which is often the case with the cathode readback), increase the values to –101.0 and 101 respectively.

e. Restart the Microsurgery program to cause the change to be recognized.

f. Compare the readback with the voltmeter reading and repeat substeps *d* and *e* as necessary until the readback is within 0.5V of the meter.

Part 11. Problem Diagnosis

General

The following section may help with diagnosing some of the more common flood gun problems. Listed below are typical operating parameters.

Cathode V: –85
Grid V: –83
Deflection V: 1 to 5 (5 would be worst case)
Filament I: 1.3 to 1.6 A (depending on gun type, age, and gas exposure).

With the system up and imaging, go to the electron faraday and center it in the field of view. Open the Electron Flood Gun Control popup (Misc menu). Try optimizing the flood gun by using the automatic calibration function (click on the Calibrate button in the Electron Flood Gun Control popup). Note any anomalies so you know where to proceed next.

If you have a picoammeter, connect it to the *EFAR* BNC on the work chamber. If you only have a voltmeter, hook it up to the *EFAR* BNC on the work chamber using the dual banana-to-BNC and a coax cable. Set the voltmeter to the mV scale. With a 10 Mohm input impedance you will see 10 mV/nA in the cup. Use this as a real-time current monitor.

Symptom: Unstable Output

Manually sweep the deflection voltage slowly using the small arrows in the popup. (A 0.1 V change on the deflection can have a big effect). Watch the meter to see if the electron faraday cup current changes significantly.

If you see that the faraday cup current gets larger, but then decreases steadily over a period of minutes or oscillates slowly, something may be charging and either deflecting or suppressing the E-gun output.

If the decrease is steady and does not return to the original value, try varying the screen or deflection voltages. If changing these potentials brings the beam back, the beam is being deflected. Possible causes of this are:

- Deposits on the electron faraday aperture (which should be cleaned about every month or whenever the gun is changed), MCP, E-Gun aperture, or deflectors
- Contamination in the gun

Symptom: Decreased Output (E-Gun aging)

Sometimes the gun life can be extended by increasing the grid voltage and readjusting the deflection.

Increase or decrease the grid voltage if the gun seems to be running out of electrons. If you find a non-standard setting that works well, change Egun.M to include this setting.

Micron

Service Procedure No.: **05-04-25**
Service Procedure Title: **Flood Gun Removal and Replacement: 25 nm Column**
Applicable Systems: **8000, Micron 9800 FlipChip**
Frequency of Service: **As needed**

Introduction

The electron flood gun (also called the E-Gun) provides charge neutralization of the sample. The flood gun voltage is supplied by the flood gun supply board (150-001130) and is controlled by the flood gun interface board (150-001090).

Materials and Tools Required

- Tie-wrap (a.k.a. Spot-tie)
- Voltmeter with at least 10 Megohm input impedance.
- Picoammeter (Optional).
- BNC - Dual Banana Adapter.
- Clip leads.
- 6 foot coax cable.
- E-Gun Board Test Circuit
- Schematic 163-00342X (E-Gun Harness)
- Clean, standard field service tool kit

This procedure uses diagnostic methods published in Tech Note 002, “Flood Gun Diagnostics.”

NOTICE

Per paragraph 11.1 of *Safety Guidelines for Semiconductor Manufacturing Equipment* (S2-93), this procedure is a Type 5 task. Specifically: “Equipment is energized and measurements and adjustments require physical entry into the equipment, or equipment configuration will not allow the use of clamp-on probes.”

Installation Pre-Check

Prior to the installation, visually check that the flood gun and the snout bore are free from contamination. Also perform the continuity checks to ensure that the filament is not open and none of the snout elements are shorted.

Part 1. System Preparation

Configure the Chemical Sources in "Safe" Mode

Before performing the tasks described in this procedure, you must put the chemical sources in a "safe" mode; see Service Procedure 02-01.

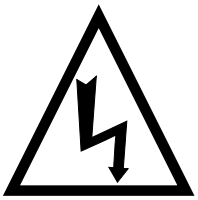
WARNING

Do not proceed until the chemical sources are secure. The chemical reservoirs in FIB systems contain hazardous materials. Labels affixed to the exterior of a chemical cabinet identify the chemical(s) contained inside. If a chemical source is not in its "safest" state, as described in **Service Procedure 02-01**, it is possible for a combination of component failures to release the chemical(s) through a cabinet's delivery line, a roughing line, a purging line, or from a chemical reservoir into the workchamber. Do not open the workchamber, or disassemble any part of the vacuum pumping system, or detach any gas line from any chemical cabinet until you are sure that every chemical source attached to the FIB system is in its "safest" state.

Power Down and Vent the System

Before performing the tasks described in this procedure, you must power down and vent the system; see Service Procedure 01-02.

WARNING



Dangerously high voltages are present in the process module while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and automatic procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

Clean off the exterior of the system as well as the floor; see Service Procedure 06-05.

Open the Workchamber

Remove the front panels to gain access to the workchamber door.

Once the system is completely vented, open the workchamber door by removing the 1/2" socket head cap screws.

Part 2. Remove the Flood Gun

2-1. Remove the flood gun electrical connectors: disconnect the grid lead, the two filament leads, and the 4-pin keyed connector (see Figures 1 and 2).

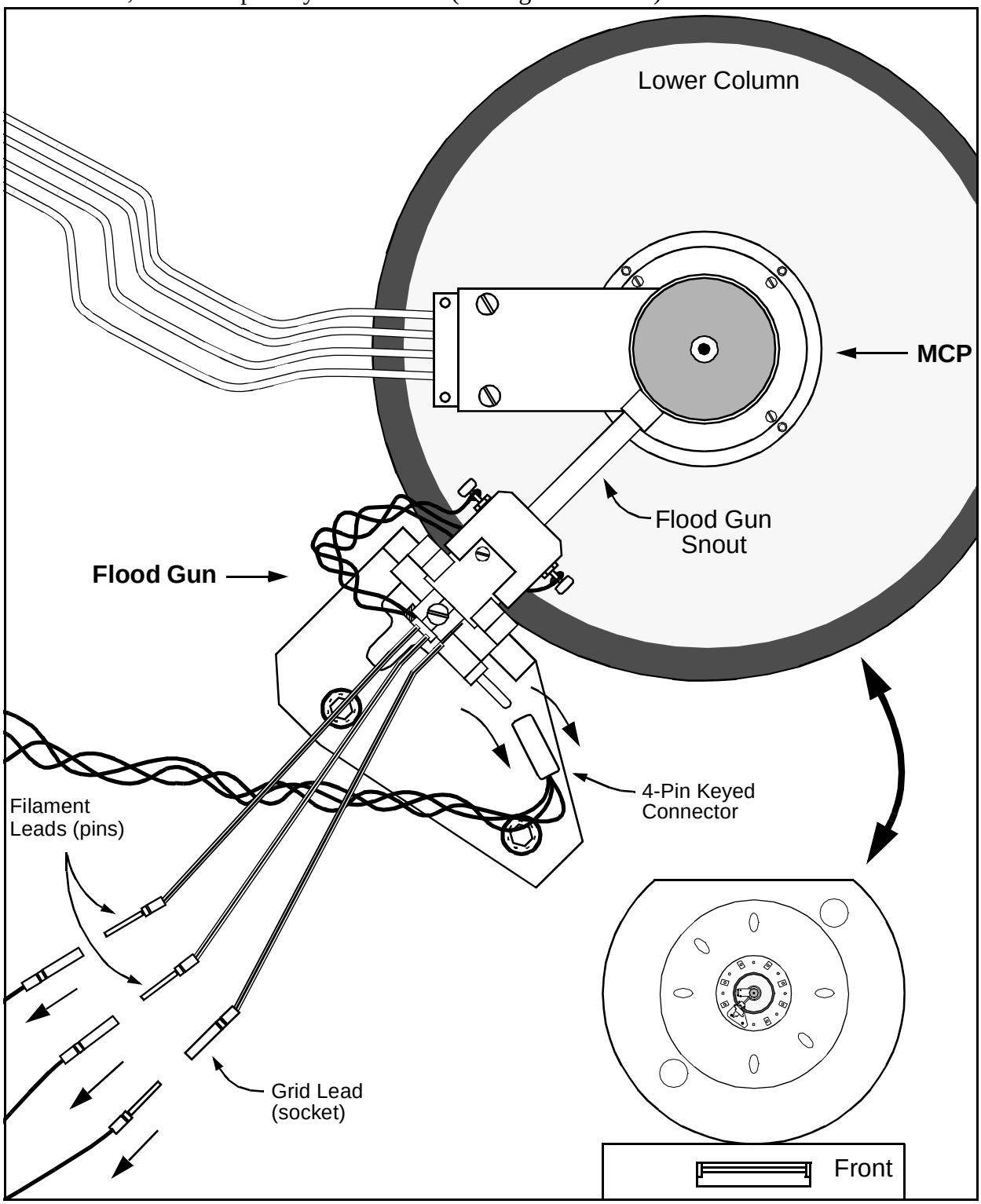


Figure 1. Interior View of Flood Gun Connections: 25 nm Column in 8000 System

Note that the position of the flood gun is different in a 9800 series system (as shown in Figure 2); the flood gun is rotated 90° to accommodate the installation of an optical microscope.

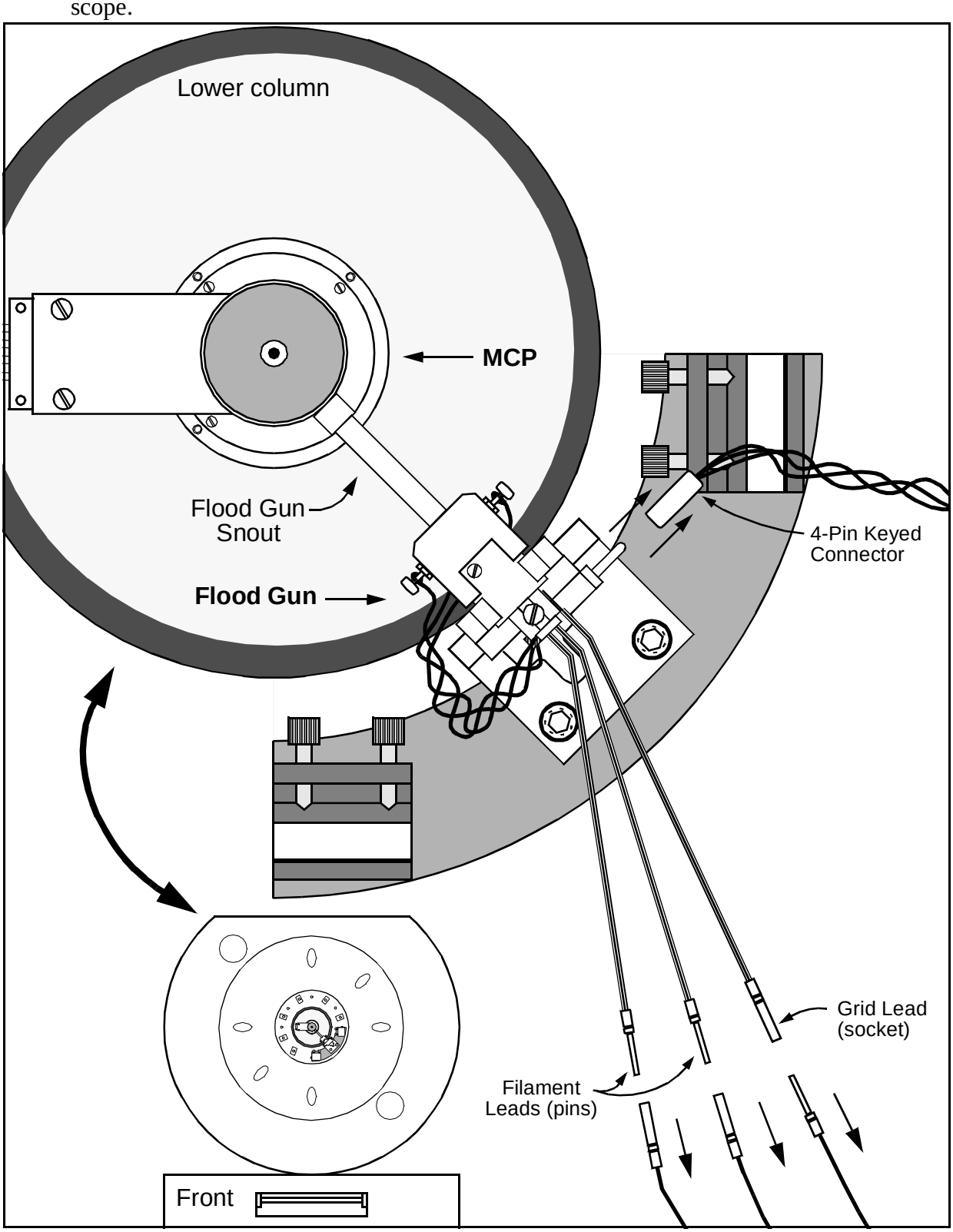


Figure 2. Interior View of Flood Gun Connections: 25 nm Column in 9800 System

NOTICE: DO NOT DROP MOUNTING SCREWS

Before removing and replacing the flood gun, place a clean lint-free wipe below the flood gun to prevent the mounting screws from falling into the turbo pump or the stage hardware. **If a screw is dropped into the workchamber, be sure to retrieve it before proceeding.**

2-2. Remove the flood gun from the workchamber lid by removing the two mounting screws as shown in Figure 3. Be careful not to damage the MCP screen.

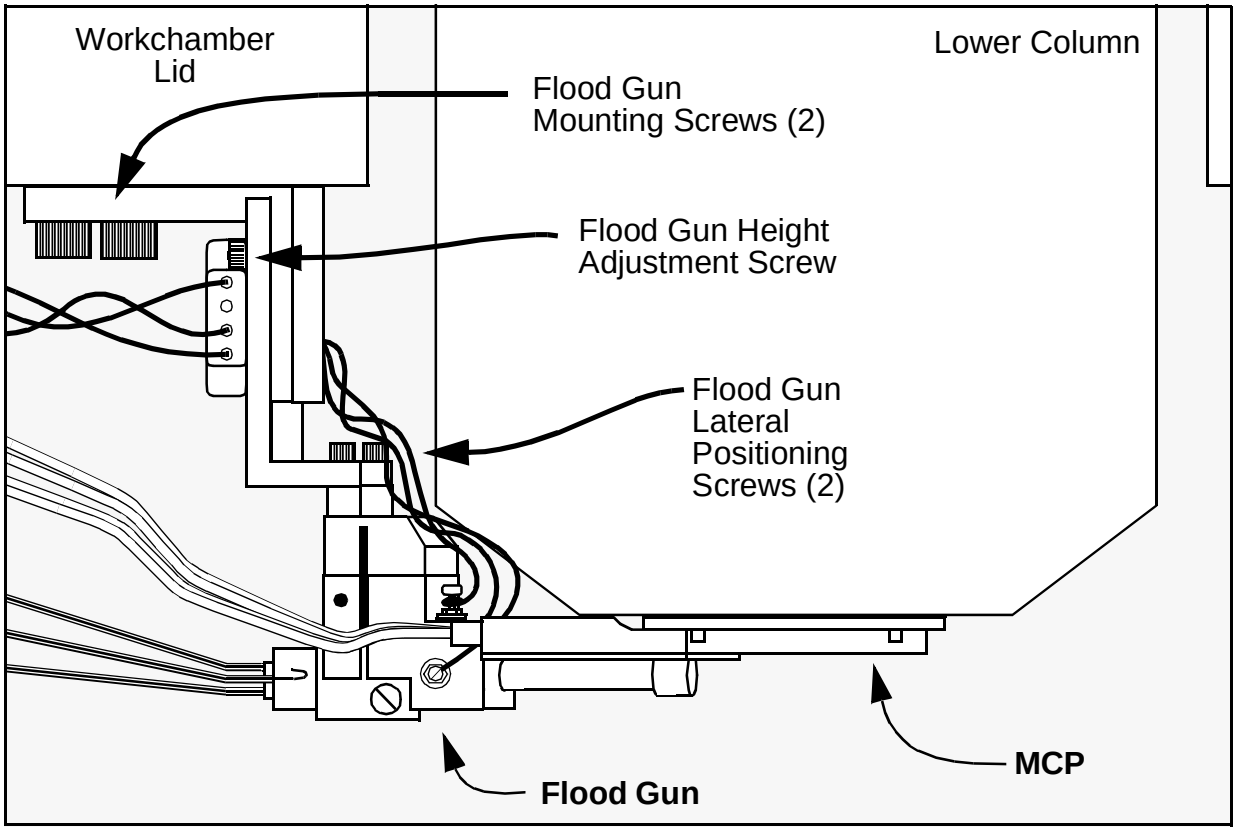


Figure 3. Side View of Flood Gun and MCP

Part 3. Inspect and Test the Replacement Flood Gun

NOTICE: THE FLOOD GUN AND ITS COMPONENTS ARE FRAGILE

Handle the flood gun with care. The flood gun leads are somewhat brittle and will break if they are bent back and forth excessively.

3-1. Remove the shipping screw (see Figure 4).

3-2. Loosen the height adjustment screw. Slide the upper bracket as far away from the lower flood gun as the height adjustment screw allows, then tighten the height adjustment screw (see Figure 4).

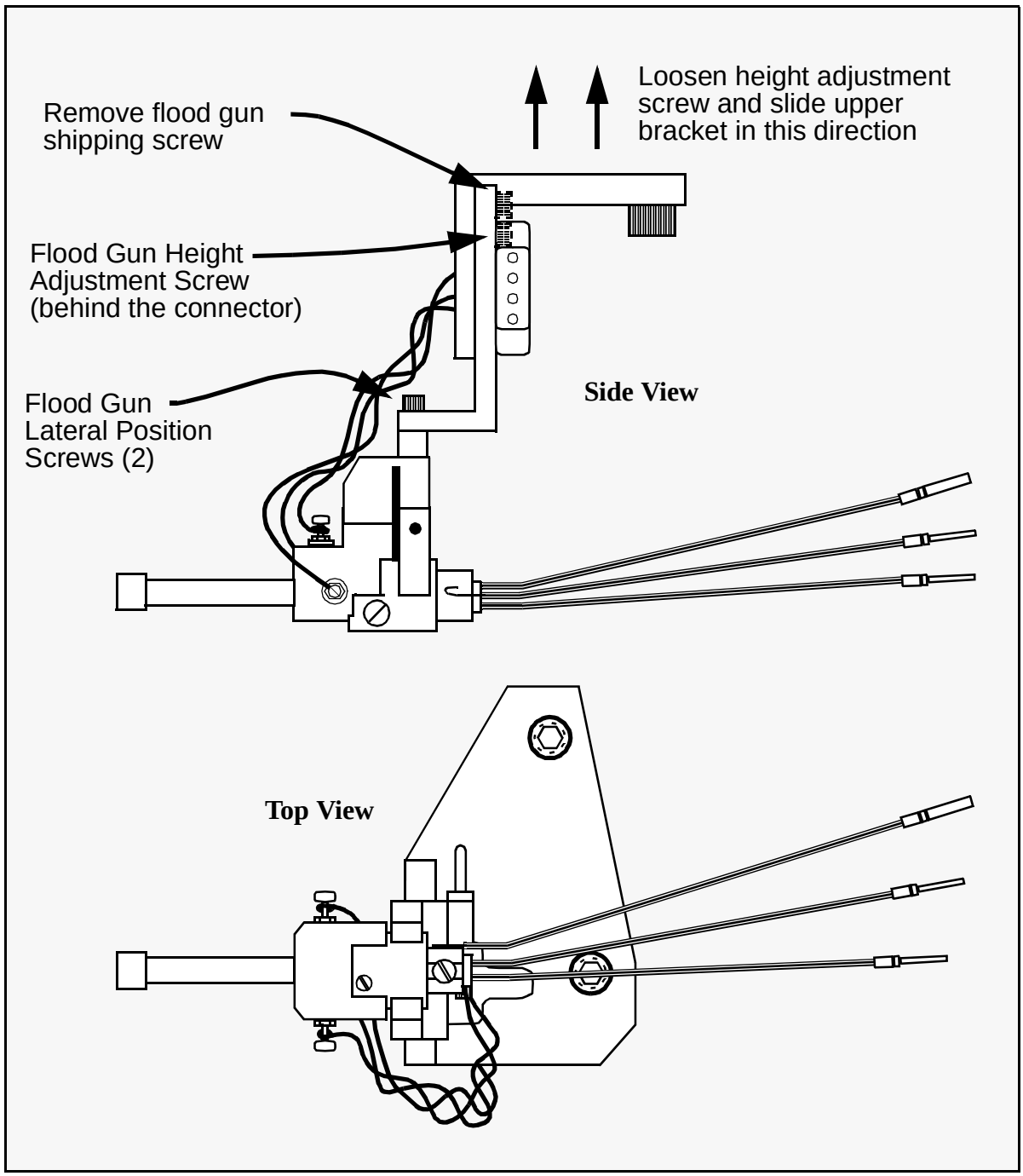

Remove flood gun shipping screw
Loosen height adjustment screw and slide upper bracket in this direction
Flood Gun Height Adjustment Screw (behind the connector)
Flood Gun Lateral Position Screws (2)
Side View
Top View

Figure 4. Side and Top Views of (Replacement) Flood Gun

3-3. Use an ohmmeter to perform the continuity tests listed in Table 1. The test measurement points are shown in Figure 5. If the measurements do not match those in Table 1, contact Micrion Customer Support.

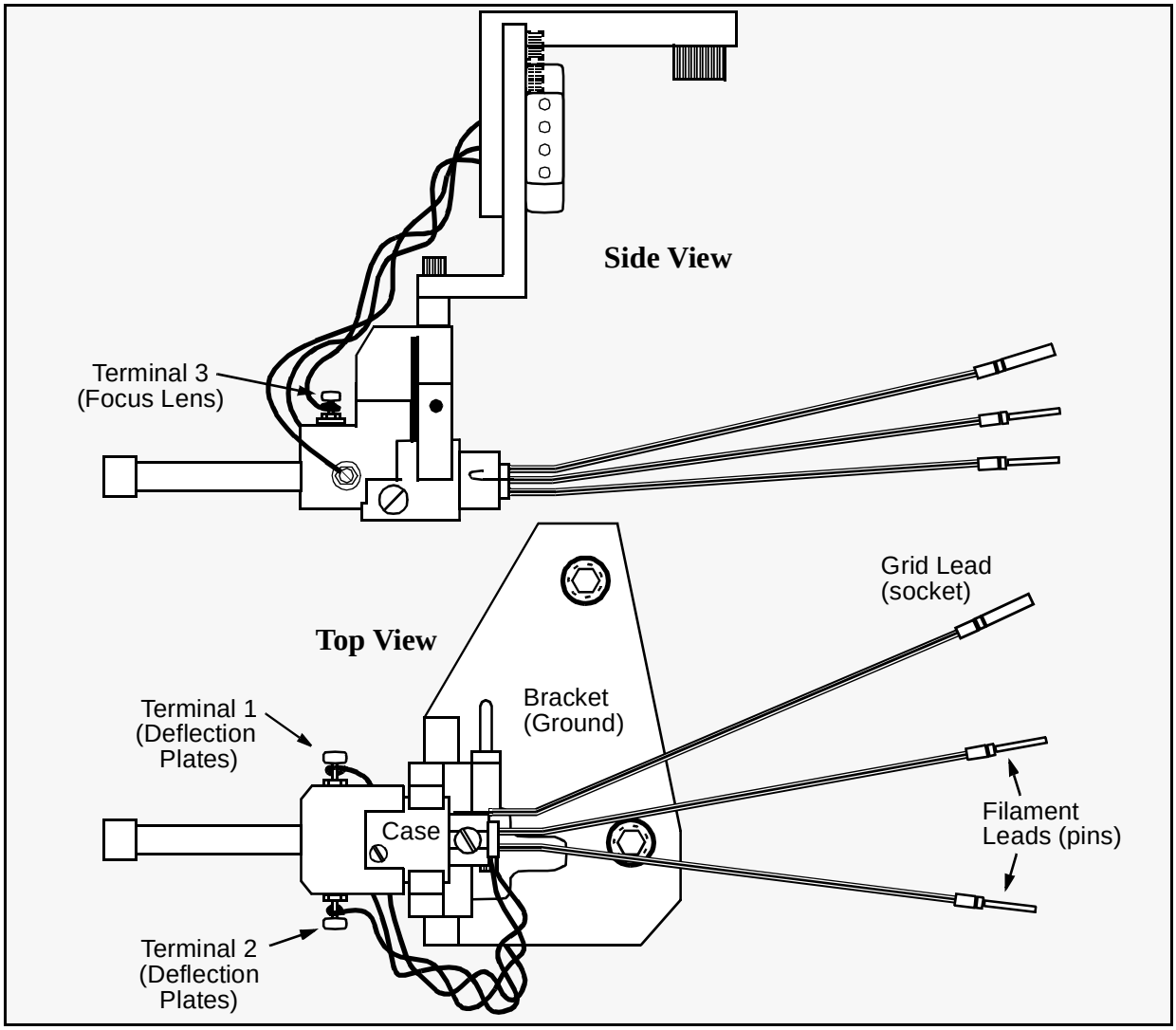


Figure 5. Flood Gun Continuity Test Points

Table 1: Flood Gun Continuity Tests

From	To	Continuity
Filament Lead 1	Filament Lead 2	Continuous
Filament Lead (either)	Ground	Not Continuous
Filament Lead (either)	Grid Lead	Not Continuous
Terminal 1	Ground	Not Continuous
Terminal 2	Ground	Not Continuous
Terminal 3	Terminals 1 & 2	Not Continuous
Case	Ground	Not Continuous

Part 4. Install the Replacement Flood Gun

4-1. Fasten the flood gun assembly to the Workchamber Lid with the mounting screws (see Figure 6).

4-2. Loosen the height adjustment screw and slide the flood gun up until the end of the flood gun snout contacts the MCP as shown in Figures 1, 2, and 3. Be careful not to damage the MCP screen. Make sure that the flood gun snout is aligned with (points directly at) the center bore of the MCP (see Figures 1 and 2). If necessary, loosen the lateral positioning screws and adjust the lateral position of the flood gun to obtain the proper orientation against the MCP (see Figure 6).

4-3. Tighten the height (and, if used, the lateral) adjustment screw(s).

4-4. Reattach the flood gun electrical connections as shown in Figures 1 and 2.

4-5. Clean the interior of the system as described in Service Procedure 06-03.

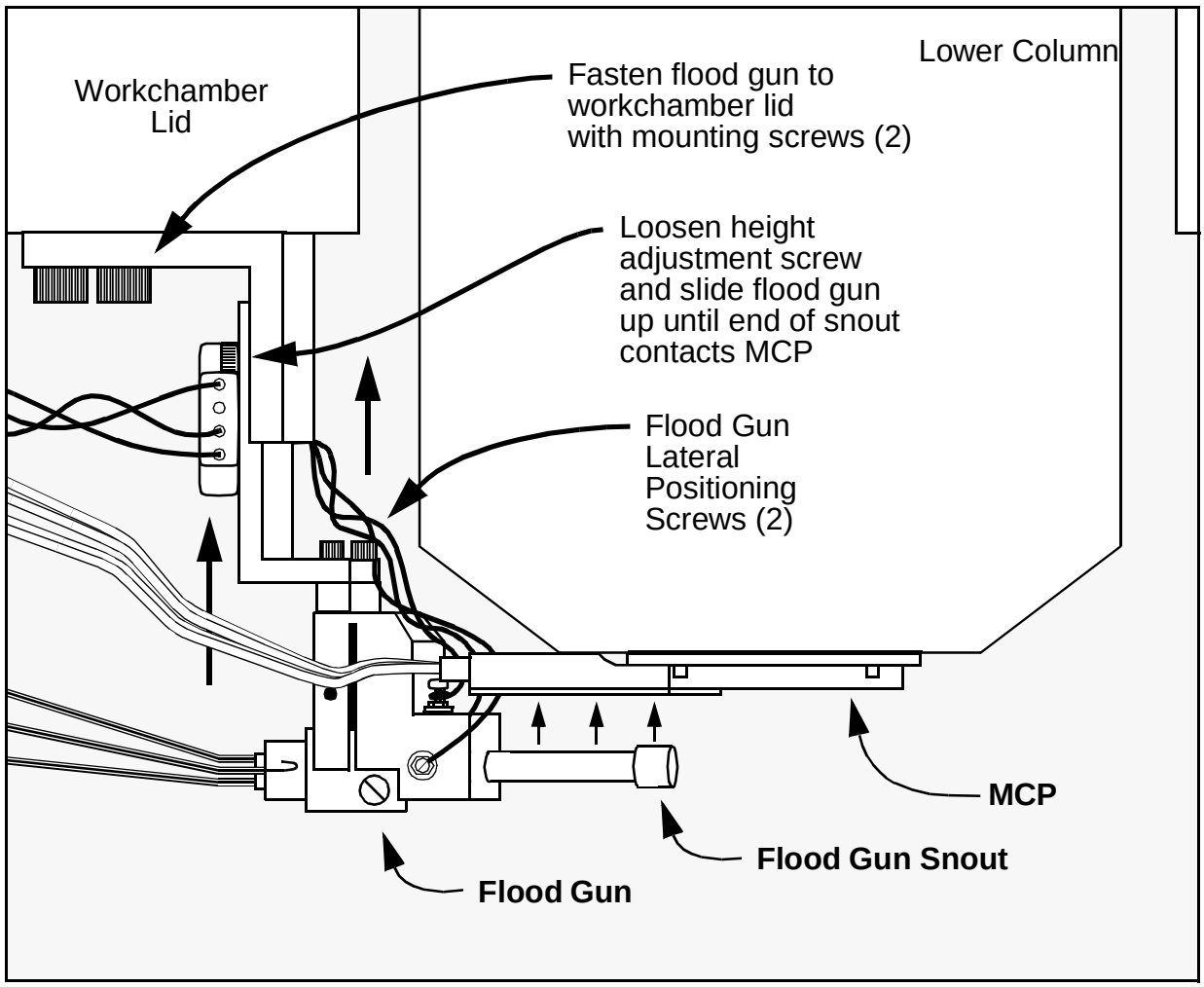

Lower Column
Workchamber Lid
Fasten flood gun to workchamber lid with mounting screws (2)
Loosen height adjustment screw and slide flood gun up until end of snout contacts MCP
Flood Gun Lateral Positioning Screws (2)
MCP
Flood Gun Snout
Flood Gun

Figure 6. Replacement Flood Gun Installation

Part 5. Power Up and Beam Up

Follow Service Procedure 01-01 to power up and bring the beam up.

Part 6. Flood Gun Control/Calibration

The Electron Flood Gun popup provides access to an automated calibration function and allows manual control of the potentials applied to the flood gun elements. This popup is accessible either through the Microsurgery program's Misc menu (select *E-Gun Control*), or through the Beam Screen (click on the flood gun graphic located to the immediate right of the image area).

An automatic calibration function is available through the Electron Flood Gun popup. To use it, make sure that the system is in ion imaging mode, and then click on the *Calibrate* button in the popup. The calibration function brings the electron faraday under the column, sweeps the various flood gun control potentials to obtain optimum current in the faraday, and then returns the stage to its former position.

To obtain popups for manually changing the potentials applied to the flood gun elements, click on the graphical representations of the elements in the Electron Flood Gun popup. For manual intervention, you must disable the flood gun maintenance software function (with the *Maintenance* button in the Electron Flood Gun popup), which monitors and adjusts the filament current to maintain constant emission (cathode current).

Part 7. Checking the Flood Gun Boards (150-001130/150-001090).

7-1. If the system is currently up, perform an Auto power down and switch off the System Controller Chassis, as explained in Service Procedure 01-02.

7-2. Remove all external connections from the 150-001130 board. (See Service Procedure 12-11, Flood Gun Supply Board, for connectors.)

7-3. Remove the 150-001130 board from its slot, place it on an extender card, and put the extender in the slot.

7-4. Switch on the System Controller Chassis. (See Service Procedure 01-01.)

7-5. Referring to Service Procedure 12-12, verify that all the proper supply voltages are present on the board.

7-6. Switch off the System Controller Chassis and return the 150-001130 board to its slot.

7-7. Repeat steps 7-2 through 7-6 for the 150-001090 board. (See Service Procedure 12-11, Flood Gun Interface Board.)

7-8. Reconnect all external connections to the 150-001130 and 150-001090 boards.

7-9. Switch on the System Controller Chassis.

7-10. Switch on the Computer and wait for the bootstrap to complete.

7-11. When prompted, log in as *micrion*.

Part 8. E-Gun Resistance Checks

8-1. In the Flood Gun Control popup:

a. Click on the filament graphic to obtain the filament control popup, and manually slide the filament control to any value and then back to ZERO.

b. Set the remaining sliders to the following values:

Grid - 0, Focus - 0, Cathode - 0, Deflection - 0, Screen - 0.

8-2. Remove the cable from connector J1801 on the E-Gun feedthrough port. Connector J1801 and the E-Gun feedthrough port are located on the right side (looking from the front of the system) of the workchamber lid. The harness number on the label should be 160-003422.

8-3. Check the connector pins on the feedthrough port (the wire harness between the feedthrough and the flood gun; not the harness between the System Controller and the feedthrough) as follows:

a. Check between pins E, F (filament), you should have continuity. If not, the E-gun filament or internal harness is open.

b. Check between pins U, G, and H (Focus lens to Deflection plates). They should be open.

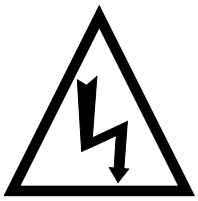
c. Check between pins T and E or F (Filament and Grid elements). They should be open.

d. Check E, F, G, H, T and U to ground. They should all be open.

Part 9. E-Gun Assembly Voltage Checks

For the following steps, use the control sliders in the popups for the focus and deflection elements. Change the slider settings and watch how both the measured (metered) and system readback voltages vary. Make sure that changes are smooth and linear over the entire slider range. If there are large jumps or other erratic behavior, a DAC, ADC or power supply may be failing. Please note the following hazard warning and take the safety precautions prescribed.

WARNING



Electrical potentials as high as 500 volts may be present at the J1801 connector when the flood gun power switch (S3) on the System Controller is in the ON position. When taking the voltage measurements described below, be sure to switch the flood gun power switch OFF before connecting or disconnecting the voltmeter probes.

9-1. Check the positive deflection voltage control as follows:

a. Switch the flood gun power switch (S3) on the System Controller OFF.

b. Connect the voltmeter between pins G (Ydef+) and P (Ground).

c. Switch the flood gun power switch (S3) on the System Controller ON.

d. Sweep the deflection slider slowly through its range and verify that the positive voltage is the same magnitude as the negative voltage (0 V to +/- 10 V), and that the readbacks track the voltmeter.

9-2. Check the negative deflection voltage control as follows:

a. Switch the flood gun power switch (S3) on the System Controller OFF.

b. Connect the voltmeter between pins H (Ydef-) and P (Ground). NOTE: This will be opposite in polarity to pin G above.

c. Switch the flood gun power switch (S3) on the System Controller ON.

d. Sweep the deflection slider slowly through its range and verify that the negative voltage is the same magnitude as the positive voltage (0 V to +/- 10 V), and that the readbacks track the voltmeter.

9-3. Check the filament voltage control as follows:

a. Make sure that the system is in ion imaging mode and that the flood gun is unblanked.

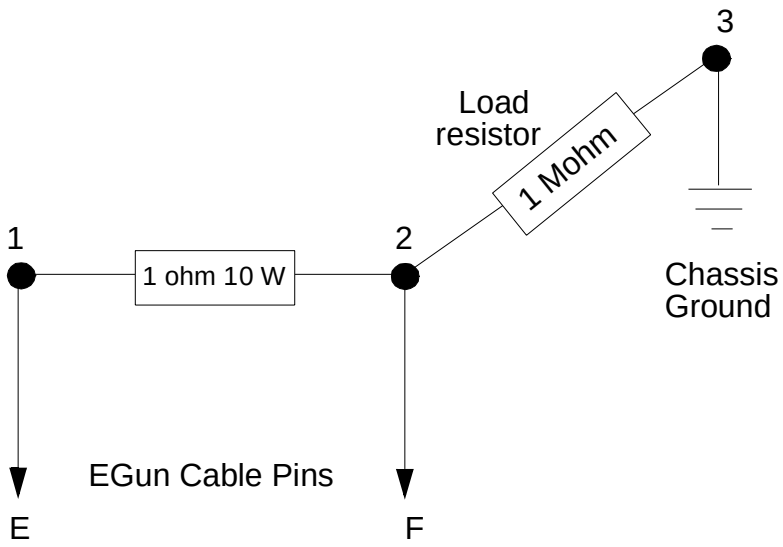
a. Switch the flood gun power switch (S3) on the System Controller OFF.

b. Connect the “Flood Gun Board Test Circuit” to pins E and F (Filament supply) of the cable connector and connect point 3 to chassis ground with a clip lead (see Fig. 6).

c. Switch the flood gun power switch (S3) on the System Controller ON.

d. Sweep the filament slider slowly through its range. Verify that the proper voltages are present and that the system readbacks track the voltmeter.

e. Disconnect the “Flood Gun Board Test Circuit”.



Point 1 to Point 2: Filament Current (I=E/R), which calculates to what is on the slider.
Point 2 to Ground: Cathode Voltage (CATV)
CATC readback on the beam control screen should equal CATV/ 1 Mohm
(If no 10W resistor is available, you can use a 1W resistor if current is brief)

Figure 7. Flood Gun Board Test Circuit

9-4. Check the grid voltage control as follows:

a. Switch the flood gun power switch (S3) on the System Controller OFF.

b. Connect the voltmeter between pins T (Grid) and P (Ground).

c. Switch the flood gun power switch (S3) on the System Controller ON.

d. Sweep the grid slider slowly through its range and verify that the voltages are from 0 V to 100 V, and that the system readbacks track the voltmeter. (If the readback differs from the voltmeter by more than 0.5 V, the readback should be corrected as described in part 10.)

9-5. Check the cathode voltage control as follows:

a. Switch the flood gun power switch (S3) on the System Controller OFF.

b. Connect the voltmeter to pins E or F (Cathode Voltage) and P (Ground).

c. Switch the flood gun power switch (S3) on the System Controller ON.

d. Sweep the cathode voltage slider slowly through its range and verify that the voltages are 0 V to 100 V, and that the system readbacks track the voltmeter. (If the readback differs from the voltmeter by more than 0.5 V, the readback should be corrected as described in part 10.)

Part 10. Grid and Cathode Voltage Readback Calibration

NOTE: If you replace the 1090 or 1130 board, recheck the calibrations as described below.

This procedure is a means of compensating the grid and cathode readback process so that the readbacks accurately reflect the potentials being applied to the flood gun. The technique is to introduce a numerical offset to the conversion of the 8-bit digital values that are read from the hardware registers on the flood gun controller. The conversion is normally based upon the assumption that the full range of values for each of these particular registers represents a voltage range of -100 to +100. This assumption is dictated by the values for the parameters `Rlowvalue` and `Rhighvalue` in the `Immersion / grid voltage` and `Cathode voltage` sections of the `Registers.M` file. These parameter values are normally -100 to +100, as is shown by the following segment from a `Registers.M` file:

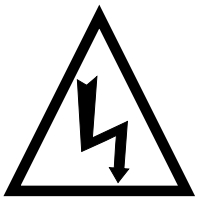
```
*Immersion / grid voltage

Wnumbits 0x00030500 12
Wlowvalue 0x00030500   0.0
Whighvalue 0x00030500   100.0
Wsoftlow 0x00030500   0.0
Wsofthigh 0x00030500   100.0
Rnumbits 0x00030500      8
Rlowvalue 0x00030500   -100.0
Rhighvalue 0x00030500   100.0
```

To introduce the offset, edit the `Registers.M` file (using the *vi* editor) to change the range specified by these parameter values. If you make the range specification smaller, for example, -99 to 99, the effective value of the LSB in the hardware register decreases, which translates to a numerically lower readback for a given voltage.

With the Electron Flood Gun control popup displayed, the system in ion imaging mode, and the flood gun unblanked, proceed as follows.

WARNING



Electrical potentials as high as 500 volts may be present at the J1801 connector when the flood gun power switch (S3) on the System Controller is in the ON position. When making the voltage measurements described below, be sure to switch the flood gun power switch OFF before connecting or disconnecting the voltmeter probes.

10-1. Calibrate the grid voltage readback as follows:

a. Switch the flood gun power switch (S3) on the System Controller OFF.

b. With J1801 unplugged from the feedthrough connector (as in part 9 above), connect the voltmeter between pins T (Grid) and P (Ground).

c. Switch the SysCon flood gun power switch (S3) ON, and note the voltmeter reading.

d. Use *vi* to adjust the values for `Rlowvalue` and `Rhighvalue` in the grid voltage section of the `Registers.M` file by one volt. For example, if the readback reads high (which is often the case with the grid voltage readback), reduce the values to –99.0 and 99 respectively.

e. Restart the Microsurgery program to cause the change to be recognized.

f. Compare the readback with the voltmeter reading and repeat substeps *d* and *e* as necessary until the readback is within 0.5V of the meter.

10-2. Calibrate the cathode voltage readback as follows:

a. Switch the flood gun power switch (S3) on the System Controller OFF.

b. Connect the voltmeter between pins E or F (Cathode Voltage) and P (Ground).

c. Switch the flood gun power switch (S3) on the System Controller ON, and note the voltmeter reading.

d. Use *vi* to adjust the values for `Rlowvalue` and `Rhighvalue` in the cathode voltage section of the `Registers.M` file by one volt. For example, if the readback reads low (which is often the case with the cathode readback), increase the values to –101.0 and 101 respectively.

e. Restart the Microsurgery program to cause the change to be recognized.

f. Compare the readback with the voltmeter reading and repeat substeps *d* and *e* as necessary until the readback is within 0.5V of the meter.

Part 11. Problem Diagnosis

General

The following section may help with diagnosing some of the more common flood gun problems. Listed below are typical operating parameters.

Cathode V: –85
Grid V: –83
Deflection V: 1 to 5 (5 would be worst case)
Filament I: 1.3 to 1.6 A (depending on gun type, age, and gas exposure).

With the system up and imaging, go to the electron faraday and center it in the field of view. Open the Electron Flood Gun Control popup (Misc menu). Try optimizing the flood gun by using the automatic calibration function (click on the Calibrate button in the Electron Flood Gun Control popup). Note any anomalies so you know where to proceed next.

If you have a picoammeter, connect it to the *EFAR* BNC on the work chamber. If you only have a voltmeter, hook it up to the *EFAR* BNC on the work chamber using the dual banana-to-BNC and a coax cable. Set the voltmeter to the mV scale. With a 10 Mohm input impedance you will see 10 mV/nA in the cup. Use this as a real-time current monitor.

Symptom: Unstable Output

Manually sweep the deflection voltage slowly using the small arrows in the popup. (A 0.1 V change on the deflection can have a big effect). Watch the meter to see if the electron faraday cup current changes significantly.

If you see that the faraday cup current gets larger, but then decreases steadily over a period of minutes or oscillates slowly, something may be charging and either deflecting or suppressing the E-gun output.

If the decrease is steady and does not return to the original value, try varying the screen or deflection voltages. If changing these potentials brings the beam back, the beam is being deflected. Possible causes of this are:

- Deposits on the electron faraday aperture (which should be cleaned about every month or whenever the gun is changed), MCP, E-Gun aperture, or deflectors
- Contamination in the gun

Symptom: Decreased Output (E-Gun aging)

Sometimes the gun life can be extended by increasing the grid voltage and readjusting the deflection.

Increase or decrease the grid voltage if the gun seems to be running out of electrons. If you find a non-standard setting that works well, change Egun.M to include this setting.

Micrion

Service Procedure No.: **05-05**
Service Procedure Title: **Aperture Mechanism Limit Switch Inspection**
Applicable Systems: **8000, Micrion 9800 FlipChip, MicroMill HT**
Frequency of Service: **As needed.**

Introduction

This procedure describes how to inspect the travel limit switches in the aperture mechanism, Micrion part no. 105-006700.

Materials Required

This procedure requires the use of the following materials and equipment:

- Standard, clean field service engineer's tool set
- Clean-room gloves
- Lint free wipes
- Laboratory-grade isopropyl alcohol

NOTICE

To operate properly, the aperture motor limit switches must be electrically connected; otherwise the mechanism may be damaged.

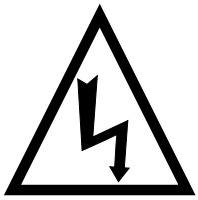
Before powering down and venting the system, clean the exterior as described in Service Procedure 06-05.

Part 1. System Preparation

Power Down and Vent the System

Before performing the tasks described in this procedure, you must power down and vent the system; see Service Procedure 01-02.

WARNING



Dangerously high voltages are present in the process module while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and automatic procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

1-1. Remove the external aperture drive mechanism as described in Parts 1, 2, and 3 of Service Procedure 05-07.

Part 2. Limit Switch Inspection

There are 3 limit travel switches in the aperture drive mechanism, as shown in Figure 1:

- y axis positive limit switch (left pivot limit)
- y axis negative limit switch (right pivot limit/home)
- x axis switch (home)

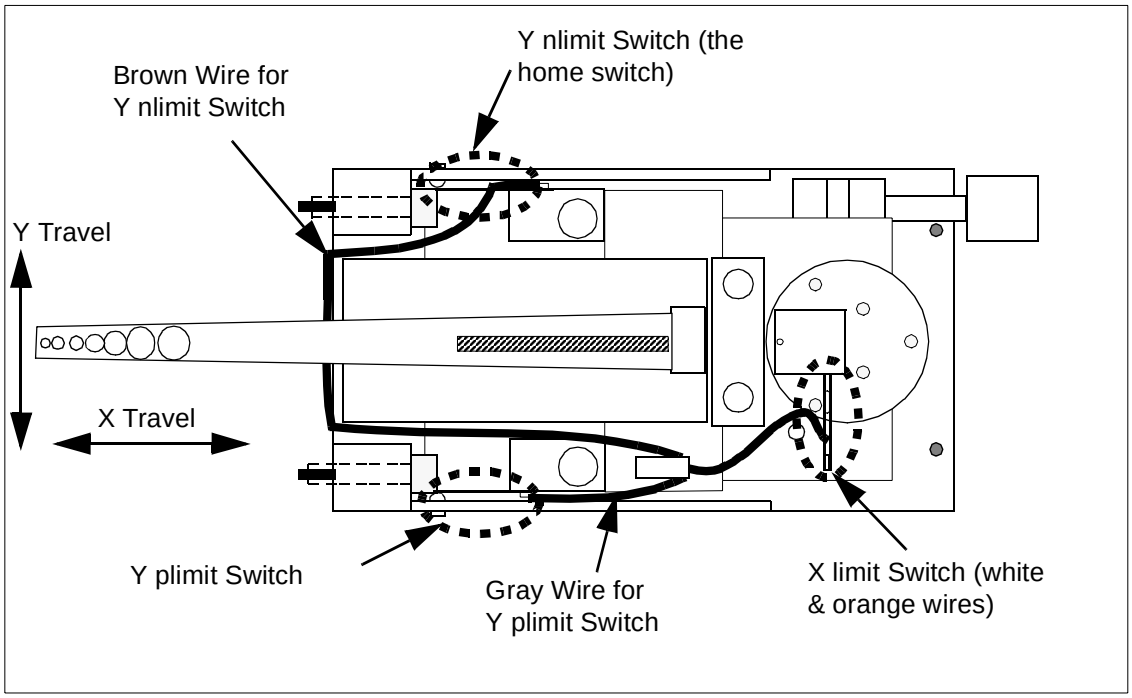

Y nlimit Switch (the home switch)
Brown Wire for Y nlimit Switch
Y Travel
X Travel
Y plimit Switch
Gray Wire for Y plimit Switch
X limit Switch (white & orange wires)

Figure 1. Aperture Mechanism and Travel Limit Switches.

The y travel limit switches (2) are composed of three parts, as shown in Figure 2:

- Contact (at ground potential)—mounts to the aperture chassis, does not move
- Pivot contact and insulator—metal strip, insulated on one side with Kapton, moves with the aperture block
- Mounting screw—mounts the pivot contact onto the nylon block

Movement of the aperture mechanism to its limit in the positive or negative y-axis causes the y travel limit switch circuits to close. Once the switch closes, power to the y aperture motor is cut off.

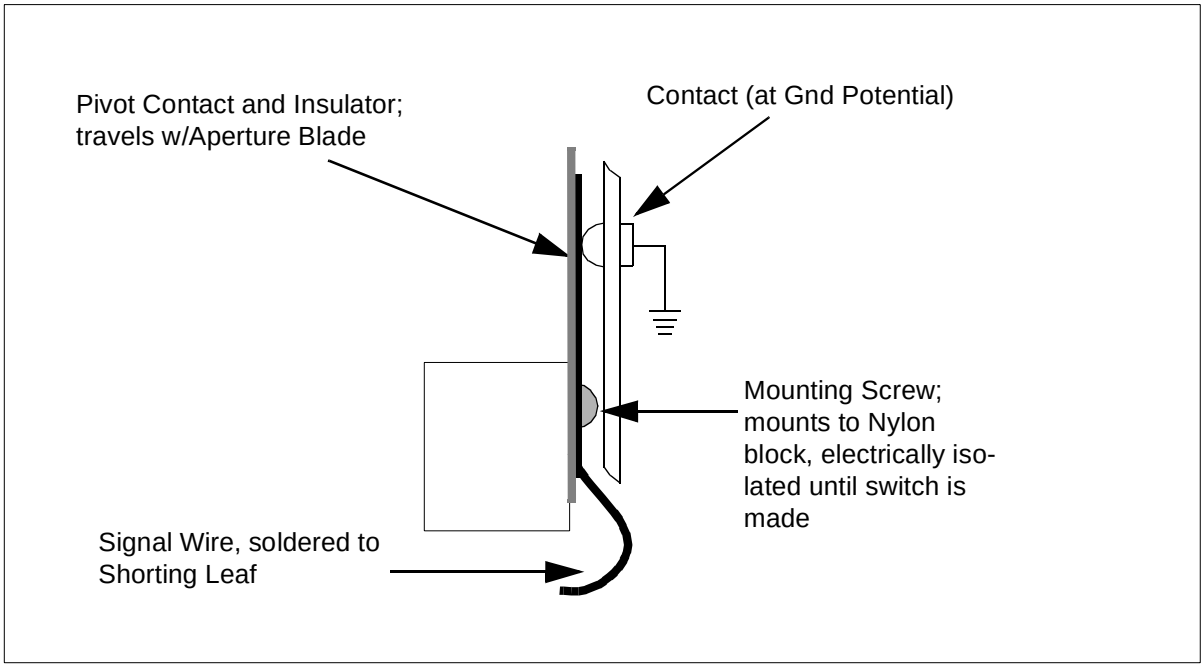


Figure 2. Y Limit Switch Expanded Top View.

The x travel limit switch is made up of two components, as shown in Figure 3:

- x rear contact leaf
- x forward contact leaf

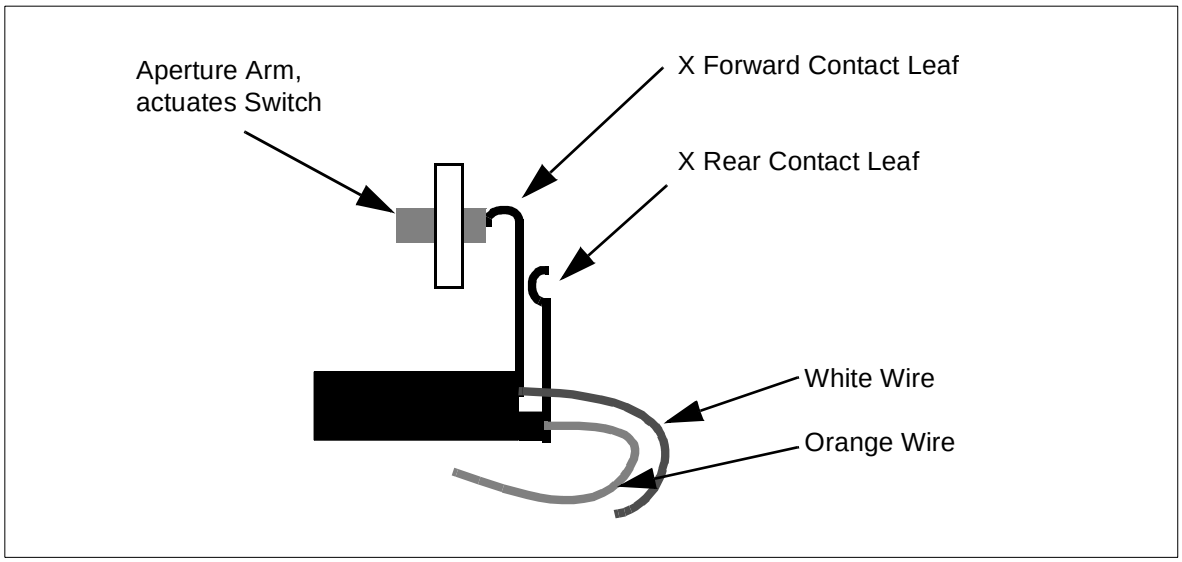


Figure 3. X Limit Switch Expanded Top View.

2-1. Make sure that the wires to the switch shorting leaf elements are securely soldered, making good electrical contact. Make sure the wires are not snagged, frayed, or otherwise in disrepair.

Do not move wires unnecessarily. Make sure the connector is plugged in.

Table 1 lists the signal names matching wire colors with the switch wiring:

Table 1: Wire Colors per Switch

Pin Number	Color	Signal Name
8	Orange	X home switch (rear aperture home)
7	Blue	Jumper to pin 3
4	Gray	Y axis + limit (left pivot limit)
3	Blue	Jumper to pin 7
2	Brown	Y home (right pivot limit)
1	White	X home switch (forward aperture home)

2-2. Inspect the limit switch shorting leafs. Make sure they are not bent, caught up, or broken.

Part 3. Software Interface

The *motorshell* program provides an interface to the drive motors and travel limit switches in the FIB system.

Use *motorshell* to get readback information about the aperture motors and travel limit switches.

Do not operate the aperture motors without the limit switches electrically connected; otherwise the mechanism may be damaged.

In an xterm window, enter the *motorshell* program by typing:

```
motorshell↵
```

For help at any time while in the *motorshell* program, type a question mark (?) followed by a return.

Micron

Service Procedure No.: **05-06**
Service Procedure Title: **External Aperture Inspection/Lubrication**
Applicable Systems: **8000, Micron 9800 FlipChip, MicroMill HT**
Frequency of Service: **Every 6 Months**

Introduction

The aperture drive gears located on the external drive plate require periodic inspection and, if necessary, lubrication.

Materials Required

This procedure requires the use of the following materials and equipment:

- Standard field service engineer's tool set
- Clean-room gloves
- Lint-free wipes
- Fluorinated solvent
- Braycote 803 white vacuum grease

WARNING

Per paragraph 11.1 of *Safety Guidelines for Semiconductor Manufacturing Equipment* (S2-93), this procedure is a Type 3 task. Specifically: "Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are less than 30 volts RMS, 42.2 volts peak, 240 volt-amps, and 20 Joules."

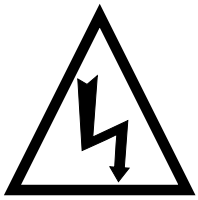
Before powering down the system, clean the exterior as described in Service Procedure 06-05.

Part 1. System Preparation

Power Down the System

Before performing the tasks described in this procedure, you must power down the system; see Part 1 of Service Procedure 01-02.

WARNING



Dangerously high voltages are present in the process module while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and automatic procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

Part 2. Inspect and Lubricate the Aperture Drives

The aperture external drive plate is located on the left side of the column as viewed from the top (see Fig. 1). The x and y drive motors are accessible from the exterior of the system. You do not have to vent the system or remove the column to gain access to the external aperture drive plate.

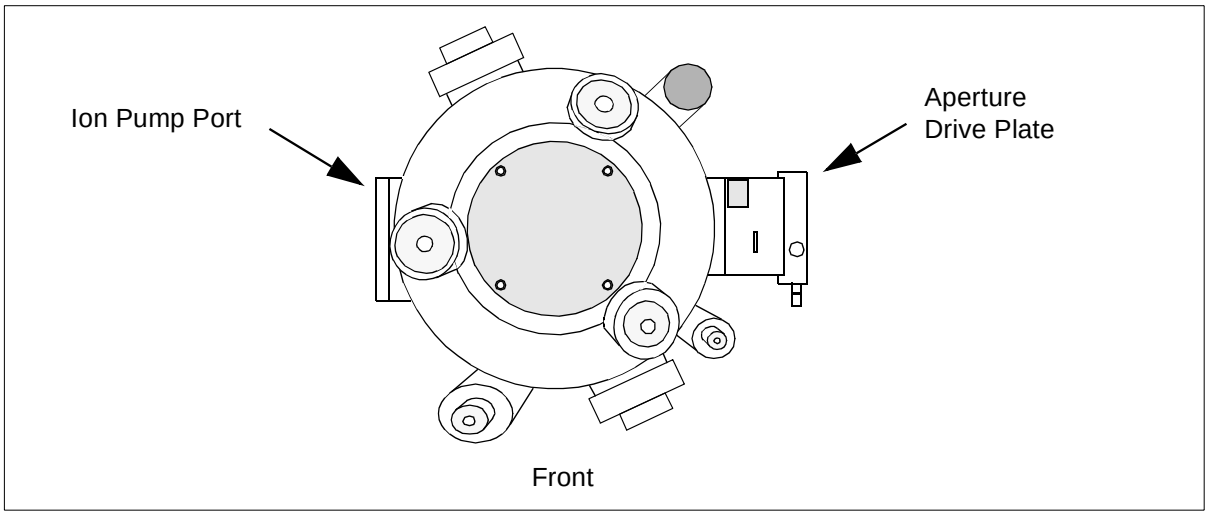


Figure 1. Location of Aperture Drive Plate on Column (Top View).

2-1. Visually inspect the worm gears for the x and y drive mechanisms. They are located on the drive plate as shown in Fig. 2.

Look for excessive wear, evidenced by metallic deposits in the lubricant residue. If there is excessive wear, call Micrion Product Support.

2-2. Determine if the lubricant residue is excessively dirty and needs cleaning. If the worm gear needs cleaning, clean it with a lint-free wipe dipped in a fluorinated solvent.

WEAR GLOVES, DO NOT HANDLE SOLVENTS

When working inside the chamber or when handling any components that will be exposed to vacuum, wear gloves rated for Class 100 environments or better. Due to disintegration of such gloves by solvents, do not handle solvents or parts that are wet with solvent.

2-3. Clean the lubricant from the gear and surrounding area using lint free wipes. Use a small amount of solvent to clean left-over residue. Avoid getting solvent on gloves.

Reapply a **small** amount of lubricant onto the gear teeth and work it in by driving the appropriate axis.

Apply more lubricant if necessary. **Do not over-lubricate** the mechanism. A minimal amount of lubricant is required to adequately lubricate the worm gears.

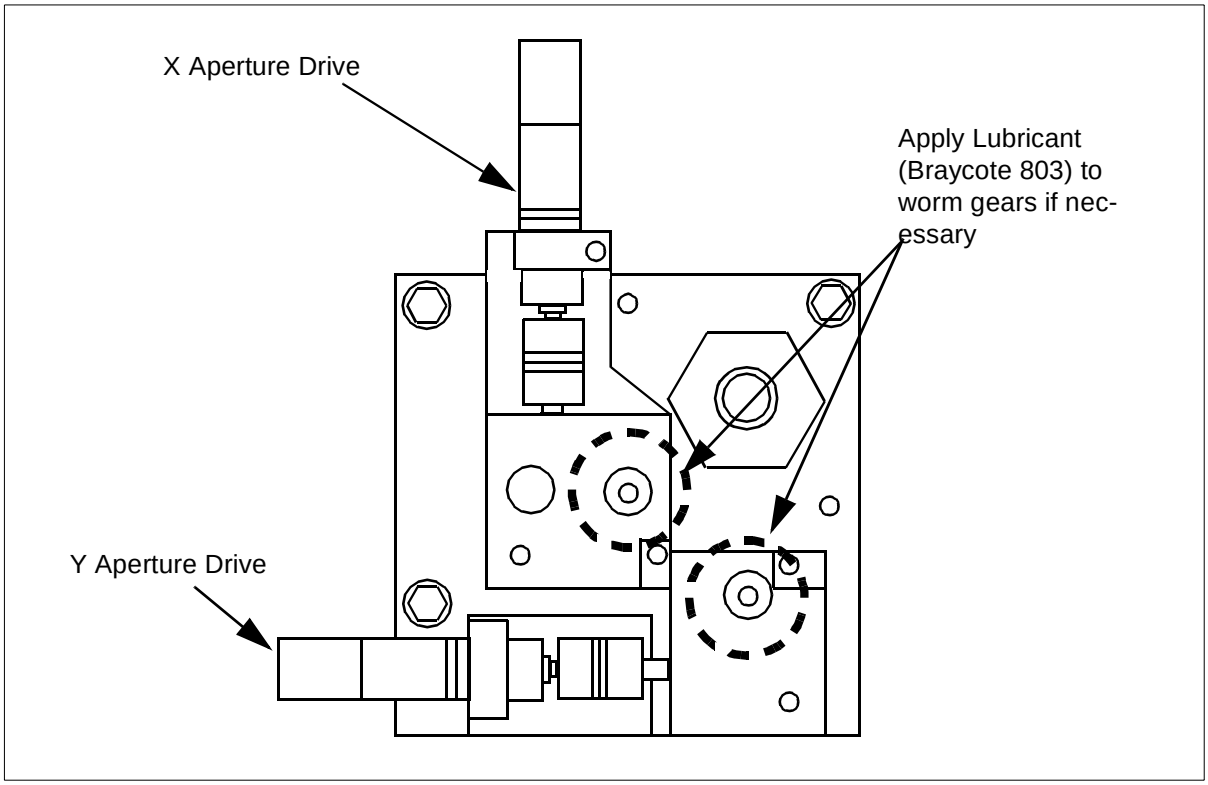


Figure 2. External Drive Plate for Aperture Mechanism with Lubrication Points.

Micrion

Service Procedure No.: **05-07**
Service Procedure Title: **Aperture Removal and Replacement**
Applicable Systems: **8000, Micrion 9800 FlipChip, MicroMill HT**
Frequency of Service: **As Needed**

Introduction

Normal system operation causes apertures to wear. When the wear is excessive, replace the aperture. Apertures may be changed individually or as a set. You may choose to replace the whole mechanism.

Column and workchamber preventive maintenance procedures, including aperture replacement, are significant sources of column contamination. While performing this procedure, take the time to thoroughly clean the column, workchamber and the area surrounding the machine.

Required Materials

This procedure requires the following materials:

- Cleanroom, preferably with a class 100 airflow hood
- Dental pick or similar tool
- Sharp wooden pick (e.g., a toothpick)
- Stereo microscope—an adjustable 10x to 70x, or a fixed 30x
- Silver paint to adhere the new apertures to the aperture blade
- Clean, standard field service tool kit
- Laboratory-grade isopropyl alcohol
- Lint-free wipes
- Clean-room gloves
- Aperture drive port blanking plate for column
- Clean-room vacuum cleaner

WARNING

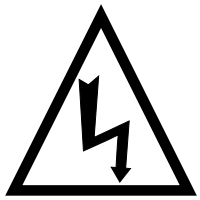
Per paragraph 11.1 of *Safety Guidelines for Semiconductor Manufacturing Equipment* (S2-93), this procedure is a Type 3 task. Specifically: "Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are less than 30 volts RMS, 42.2 volts peak, 240 volt-amps, and 20 Joules."

Part 1. System Preparation

Power Down and Vent the System

Before powering down and venting the system, clean the exterior as described in Service Procedure 06-05. Then power down and vent the system; see Service Procedure 01-02.

WARNING



Dangerously high voltages are present in the process module while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and automatic procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

Part 2. Remove or Loosen the Column

The aperture drive mechanism containing the beam limiting apertures is located on the column. You might choose to remove the column to gain access to the aperture mechanism.

2-1. Using the Aperture popup, home the apertures.

2-1. If you choose to remove the column, remove the column as described in Service Procedure 05-09-05 (for 5 nm), 05-09-10 (for 10 nm), or 05-09-25 (for 25 nm). If you leave the column on the process module, remove the column cap (ion source) assembly from the column as described in the column removal service procedure.

CAUTION

The column assembly weighs approximately 50 lbs. Use proper care when lifting it to avoid injuring yourself or damaging the column. Remove the ion gun assembly from the column and then move the column. Obtain the help of another person.

Part 3. Remove Aperture Drive Plate and Mechanism

You must wear clean-room gloves while performing these steps.

3-1. Remove the three socket-head screws holding the aperture drive motor plate to the column housing (see Figure 1).

a. Carefully pull the aperture drive motor plate away from the column housing until the internal wire harness is visible.

b. Note the color sequence of the wires: use Table 1 for wiring color sequence.

3-2. Disconnect the wires and place the motor plate in a clean area.

Table 1: Aperture Drive Wire Colors

Pin	Color	Signal
8	Orange	X Home Switch
7	Blue	Jumper to pin 3
4	Gray	Y+ Limit (left pivot)
3	Blue	Jumper to pin 7
2	Brown	Y Home (right pivot)
1	White	Forward Aperture Home

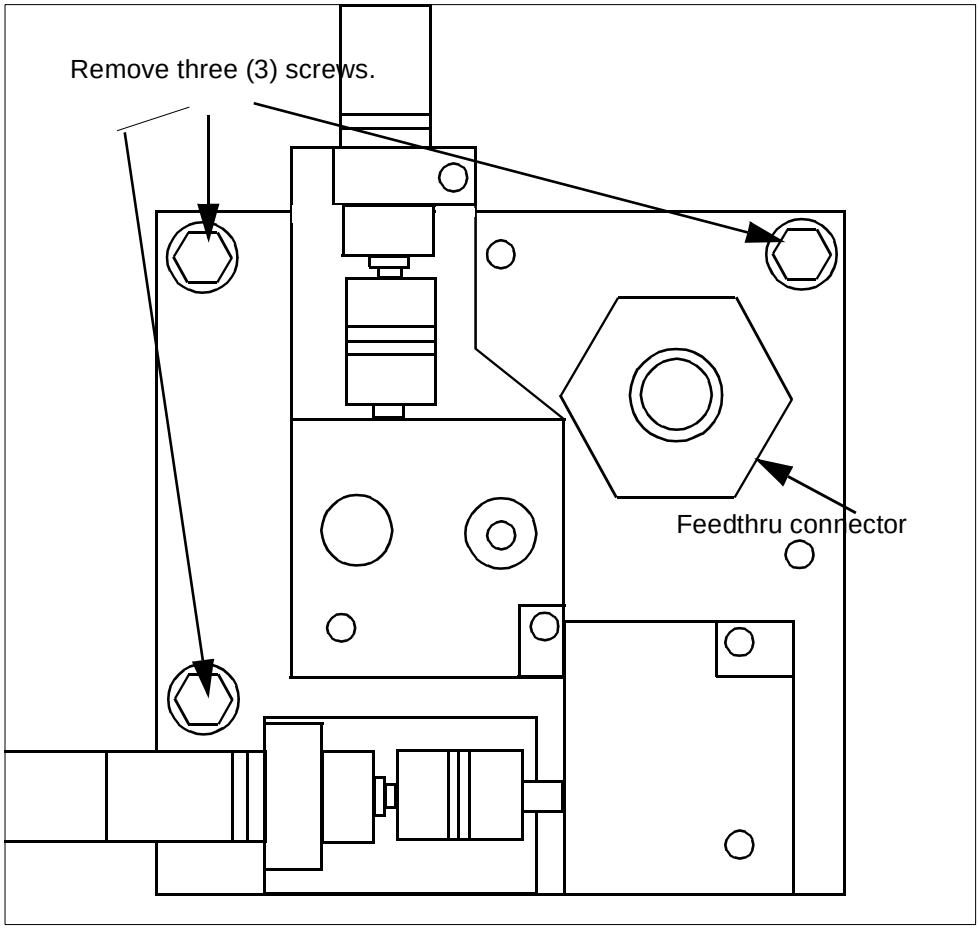


Figure 1. Aperture Plate Held by Three Screws

NOTICE: BE CAREFUL WITH HEX DRIVER

Be careful, when inserting the hex driver, not to damage the wires or scratch the lens elements and not to mar any of the ceramic insulators.

3-3. Clean tools before using them to be sure they are free of oils, greases, or other contaminants. Refer to Fig. 2 while performing the following steps.

a. Use a long 3/32" ball hex driver to remove the two 4-40 screws that hold the aperture mechanism to the mounting block on the column drift tube. These screws are retained in the assembly. Do not remove the screws from the assembly.

b. Carefully remove the aperture mechanism and place it in the prepared clean area.

c. Place the blanking plate on the column to minimize particulate contamination.

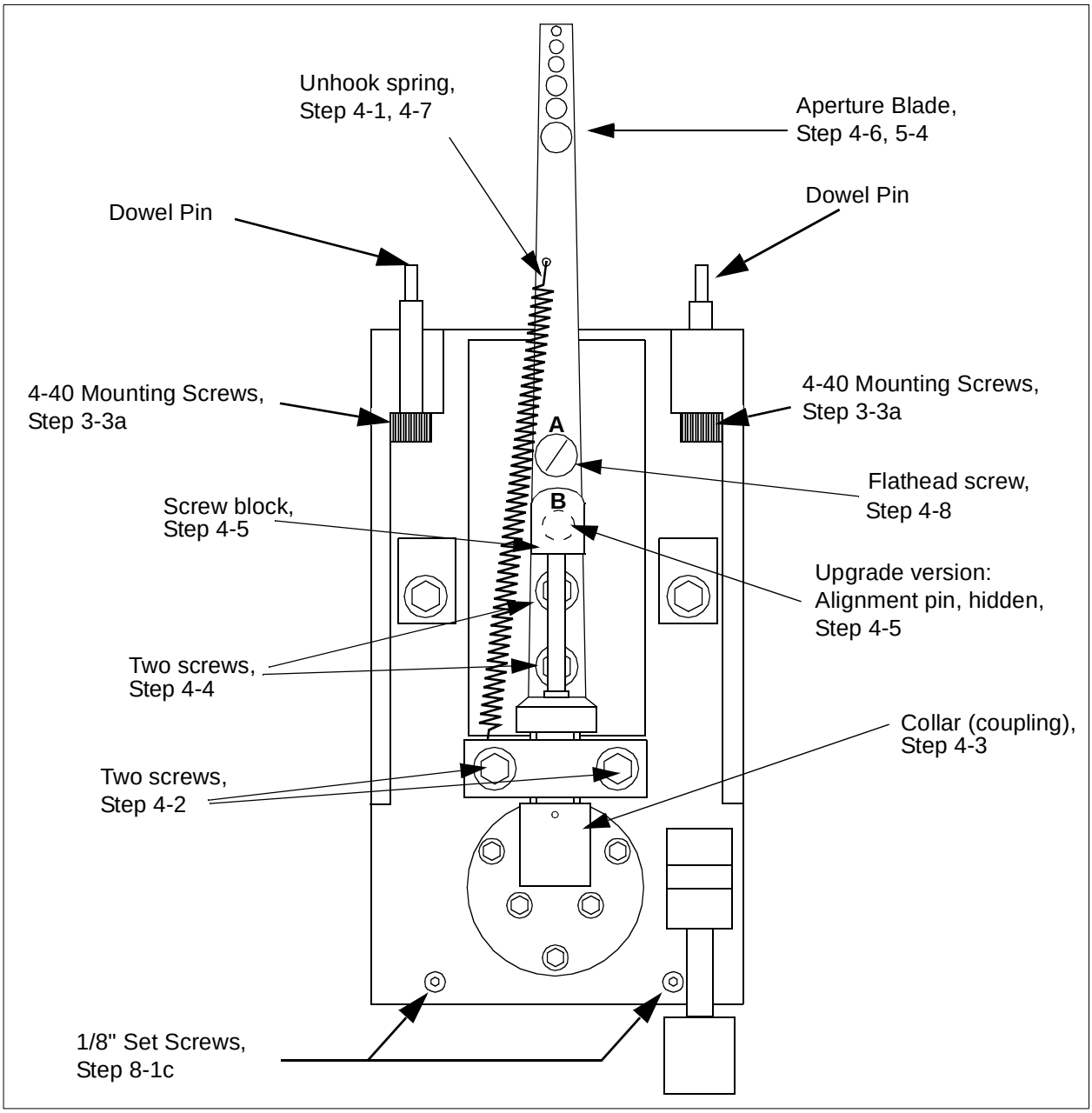


Figure 2. Top View of Aperture Mechanism.

Part 4. Removing a Standard Aperture Blade

In the following procedure, a **standard aperture blade** means one that is held in place with two flathead countersunk screws; an **upgrade aperture blade** means one that is held in place with one flathead countersunk screw and one alignment pin.

If you are replacing a standard aperture blade with an upgrade aperture blade, proceed as follows:

4-1. Unhook the spring from the aperture blade (see Fig. 2).

4-2. Remove two 5/16" socket head cap screws. Alignment is critical when reassembling.

4-3. Rotate the collar (coupling) counterclockwise until the slide screw unthreads from the screw block.

4-4. Remove two screws holding the screw block in place. Alignment is critical when reassembling.

4-5. Lift the screw block out of the way and screw in an alignment pin where shown (**B** in Figs 2 and 3.

4-6. Remove the two 4 mm scoket-head cap screws and lift the aperture blade free.

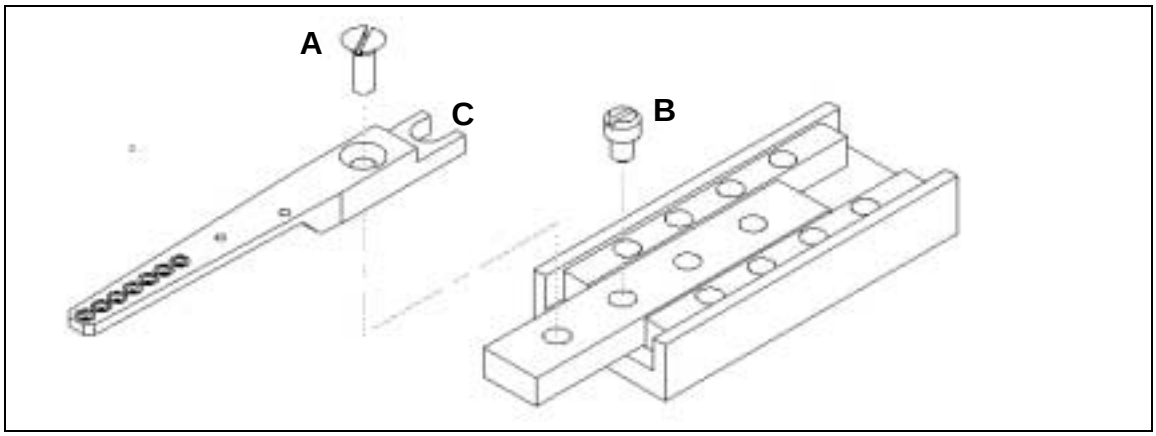


Figure 3. Upgrade Aperture Blade, detail

Part 5. Removing an Upgrade Aperture Blade

If you are replacing an upgrade aperture blade with another upgrade version, proceed as follows. The upgrade version of the aperture blade is shown in Fig. 2 (**A** and **B**) and in detail in Fig. 3; it is mounted by one removable screw **A**), and by one alignment pin **B**) that engages the slot **C**) at the end of the aperture blade.

5-1. Inspect the end of the aperture blade for an alignment pin and slot; the alignment. pin and slot indicate that this aperture blade can be removed in three steps:

5-2. Unhook the spring from the aperture blade (see Fig. 2).

5-3. Loosen and remove the flathead countersunk screw (**A** in Figs. 2 and 3).

5-4. Pull the aperture blade out.

Part 6. Replacing or Cleaning Individual Apertures

If you are replacing the entire aperture blade, go to Part 5. If you are replacing the entire aperture mechanism, go to Part 8.

6-1. Place the aperture mechanism under a microscope. Locate the aperture(s) you want to replace.

6-2. Remove the aperture(s) by carefully scraping away the silver paint with a dental pick.

6-3. With the aperture(s) removed, clean the counterbores on the aperture blade by scraping away any remaining silver paint with a sharp **wooden** pick. Do not scratch the aperture counter bores. Also, while removing the silver paint, be careful not to contaminate any other portions of the aperture blade with paint residue. Blow away loose particles with dry nitrogen.

6-4. Shake the silver paint to mix it thoroughly.

6-5. Under the microscope, insert the new aperture(s) in the correct position(s) on the aperture blade, and bond it (them) in place with silver paint.

Do not get any paint inside the new aperture bore.

Make sure that any counter-bores in the aperture face **away** from the source.

Part 7. Installing an Upgrade Aperture Blade

The installation of an upgrade aperture blade takes three steps:

7-1. Wearing clean room gloves, insert the aperture blade until the slot meets the alignment pin.

7-2. Align the travel of the apertures bores to be parallel with the travel of the blade.

7-3. Insert and tighten the flathead countersunk screw (**A** in Fig. 3).

Part 8. Install the Aperture Mechanism and Drive Plate

8-1. Return the aperture mechanism to the column housing.

a. Insert the two alignment pins on the aperture mechanism into the mounting block holes inside the column.

b. If the set screws are **not** touching, snug-tighten the two 4-40 screws that hold the aperture mechanism to the mounting block on the column drift tube.

c. Very lightly, tighten the two 1/8" set screws until they *just start* to bear against the inside of the column housing. The set screws stabilize the slide mechanism when apertures are selected or adjusted. Do not overtighten these screws.

8-2. Replace the aperture drive motor plate.

a. Inspect the o-ring and adjacent seal surfaces on the motor plate for lint or hair. Clean if necessary.

b. Line up the drive couplings. You may have to align the drive couplings so they engage when reinstalling the drive on the column.

c. Reconnect the wires removed in step 3-1.

d. Fasten the motor plate to the column housing using the three 8-32 socket head screws (see Fig. 1).

8-3. If you have removed the column to perform this procedure, clean the column elements.

8-4. If you have removed the column to perform this procedure, install it as described in Part 4 of Service Procedure 05-09.

8-5. Clean the workchamber, the ion pump tube, and the loadlock.

8-6. Close up the system and pump down in the normal manner. Allow the system to reach working vacuum levels and then power up in the normal manner.

Part 9. Cure and Calibrate the Apertures

9-1. Cure the column and lenses (see Service Procedure 05-12).

9-2. Align the column apertures (see Service Procedure 05-13).

9-3. Perform the deflection system calibrations as described in Section 7 of this manual.

Micrion

Service Procedure No.: **05-09-05**
Service Procedure Title: **Column Removal and Replacement: 5 nm Column**
Applicable Systems: **8000, Micrion 9800 FlipChip, MicroMill HT**
Frequency of Service: **As needed.**

Introduction

This procedure describes the process of removing and replacing the ion beam column in the FIB system.

Materials Required

This procedure requires the use of the following materials:

- Clean, standard field service tool kit
- Lint-free wipes
- Clean-room gloves
- Laboratory-grade isopropyl alcohol
- Port blanking plates for the ion pump-column port and process module column port

NOTICE

Per paragraph 11.1 of Safety Guidelines for Semiconductor Manufacturing Equipment (S2-93), this procedure is a Type 3 task. Specifically: "Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are less than 30 volts RMS, 42.2 volts peak, 240 volt-amps, and 20 Joules."

Part1. System Preparation

Configure the Chemical Sources in "Safe" Mode

Before performing the tasks described in this procedure, you must put the chemical sources in a "safe" mode; see Service Procedure 02-01.

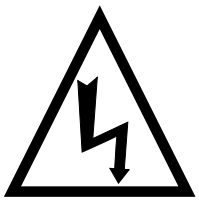
WARNING

Do not proceed until the chemical sources are secure. The chemical reservoirs in FIB systems contain hazardous materials. Labels affixed to the exterior of a chemical cabinet identify the chemical(s) contained inside. If a chemical source is not in its "safest" state, as described in **Service Procedure 02-01**, it is possible for a combination of component failures to release the chemical(s) through a cabinet's delivery line, a roughing line, a purging line, or from a chemical reservoir into the workchamber. Do not open the workchamber, or disassemble any part of the vacuum pumping system, or detach any gas line from any chemical cabinet until you are sure that every chemical source attached to the FIB system is in its "safest" state.

Power Down and Vent the System

Before performing the tasks described in this procedure, you must power down and vent the system; see Service Procedure 01-02.

WARNING



Dangerously high voltages are present in the process module while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and automatic procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

Open the Workchamber

Before opening the workchamber, clean the exterior panels.

Remove the front panels to gain access to the workchamber door.

Clean the workchamber and the loadlock exterior as described in Service Procedure 06-05.

Once the system is completely vented, open the workchamber door by removing the 1/2" socket head cap screws.

Part 2. Lower the Flood Gun, Remove the MCP Connectors

WEAR GLOVES, DO NOT HANDLE SOLVENTS

When working inside the chamber or when handling any components that will be exposed to vacuum, wear gloves rated for Class 100 environments or better. Due to disintegration of such gloves by solvents, do not handle solvents or parts that are wet with solvent.

2-1. After the system has vented, open the workchamber. Two types of flood gun/MCP configurations are installed in FIB systems with 5 nm columns: a flood gun without a snout combined with a small MCP[1] (as shown in Figures 1 and 2), and a flood gun with a snout paired with a large MCP[2] (as shown in Figures 3, 4, and 5).

2-2. Wearing clean room gloves, loosen the flood gun height positioning screw (see Figures 6 and 7) and slide the flood gun assembly down to provide access to the MCP.

2-3. Remove the MCP electrical connectors (see Figures 6 and 7).

[1] There are two styles of small MCP: flat and angled (see Figure 2). Both styles have the same fasteners and electrical connectors.

[2] There are two configurations of the flood gun with a snout and large MCP combination (see Figures 3 and 4). In a 9800 series system (as shown in Figure 4), the flood gun is rotated 90° to accommodate the installation of an optical microscope.

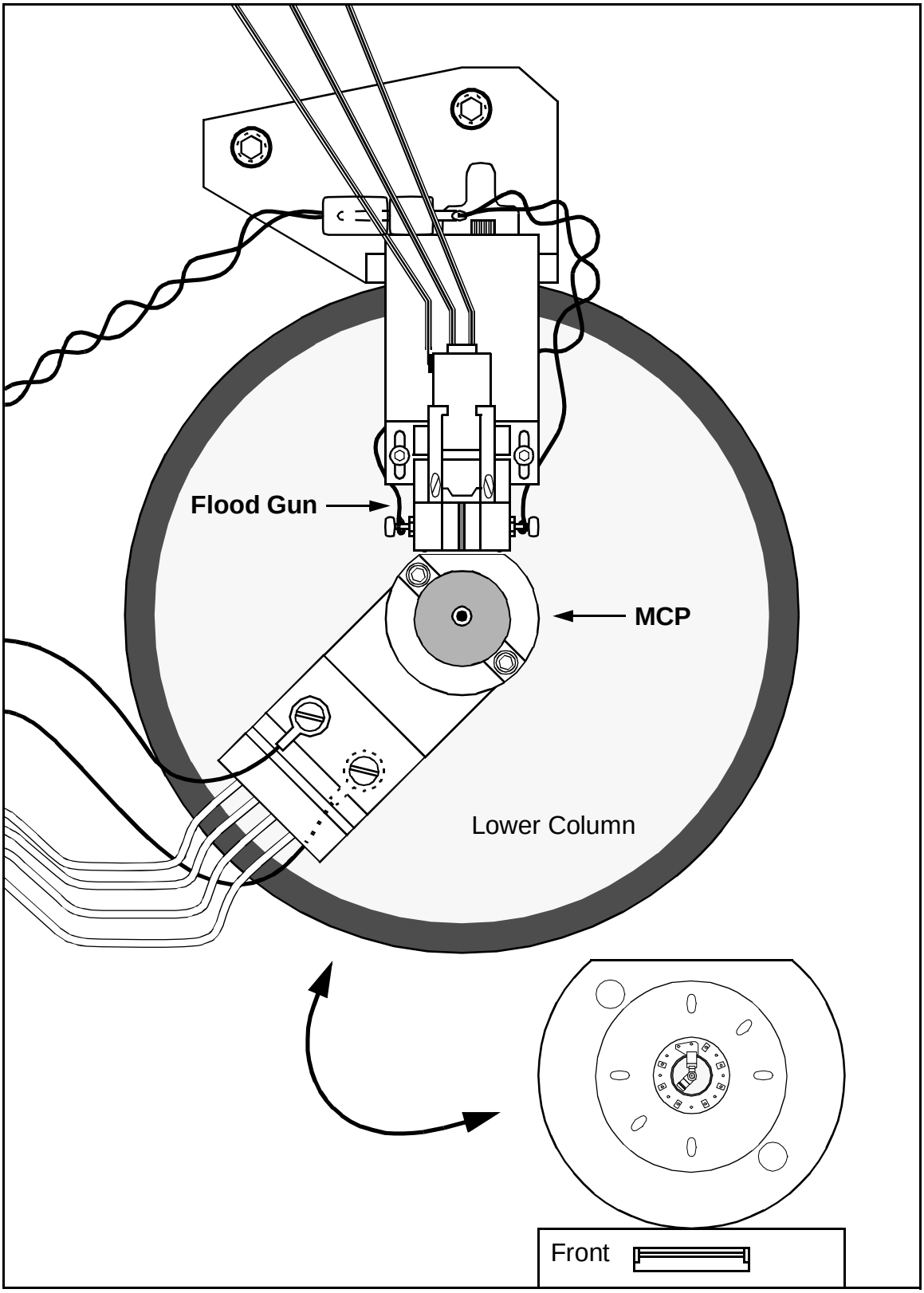


Figure 1. Flood Gun Without Snout and Small MCP: Interior View

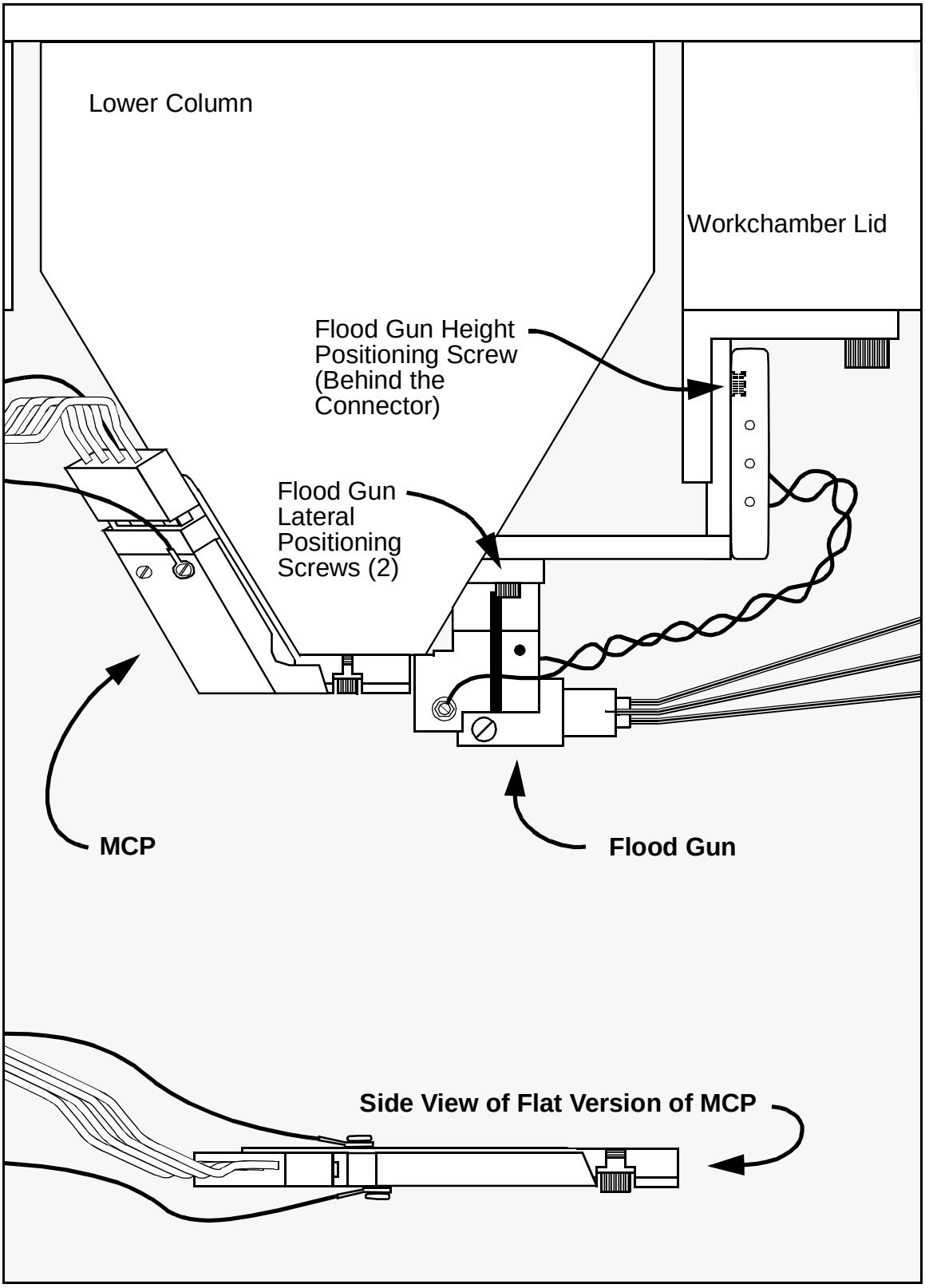

Lower Column
Workchamber Lid
Flood Gun Height Positioning Screw (Behind the Connector)
Flood Gun Lateral Positioning Screws (2)
MCP
Flood Gun
Side View of Flat Version of MCP

Figure 2. Side View of Flood Gun Without Snout and Small MCP(s)

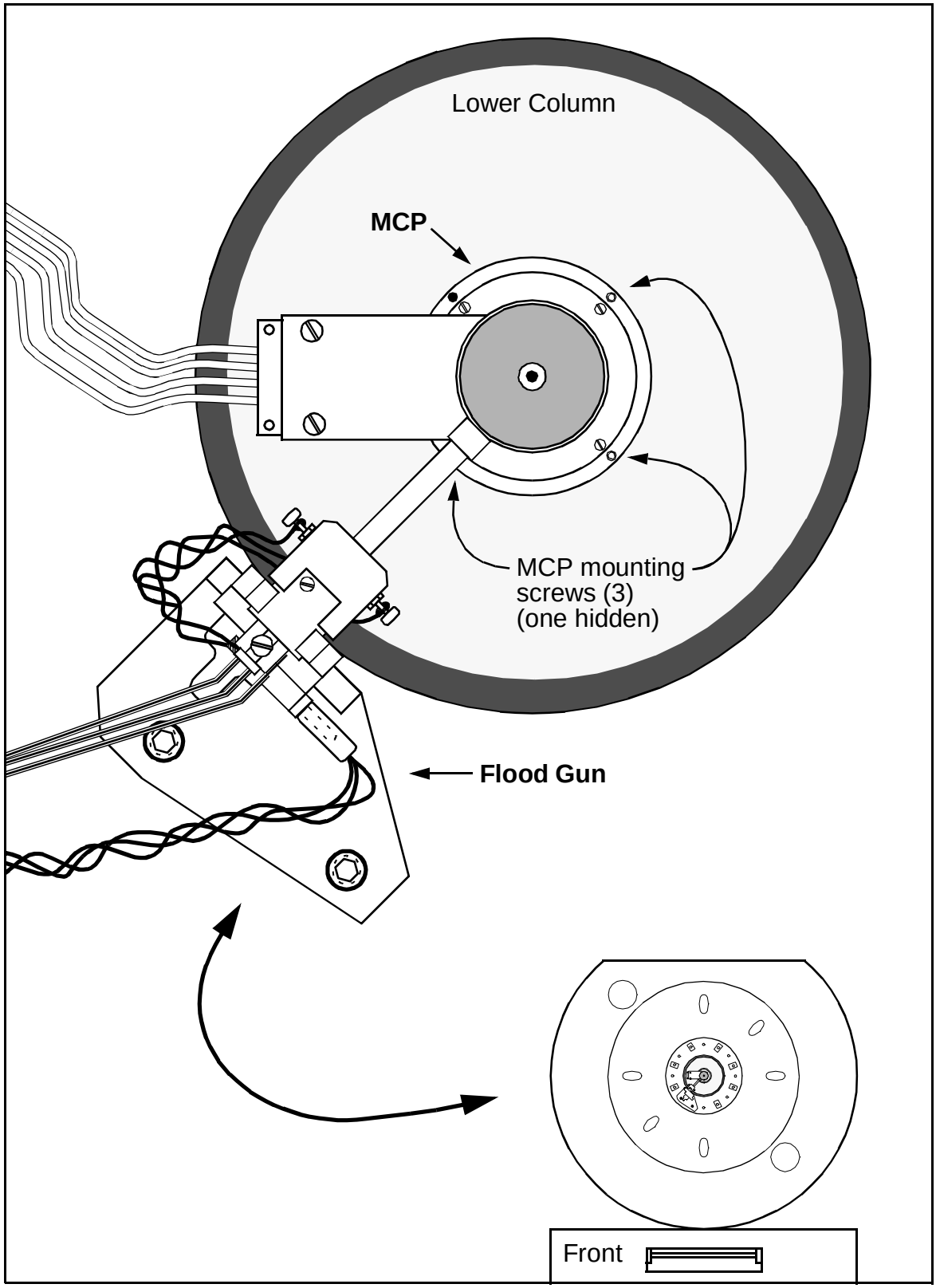


Figure 3. Flood Gun With Snout and Large MCP: Interior View

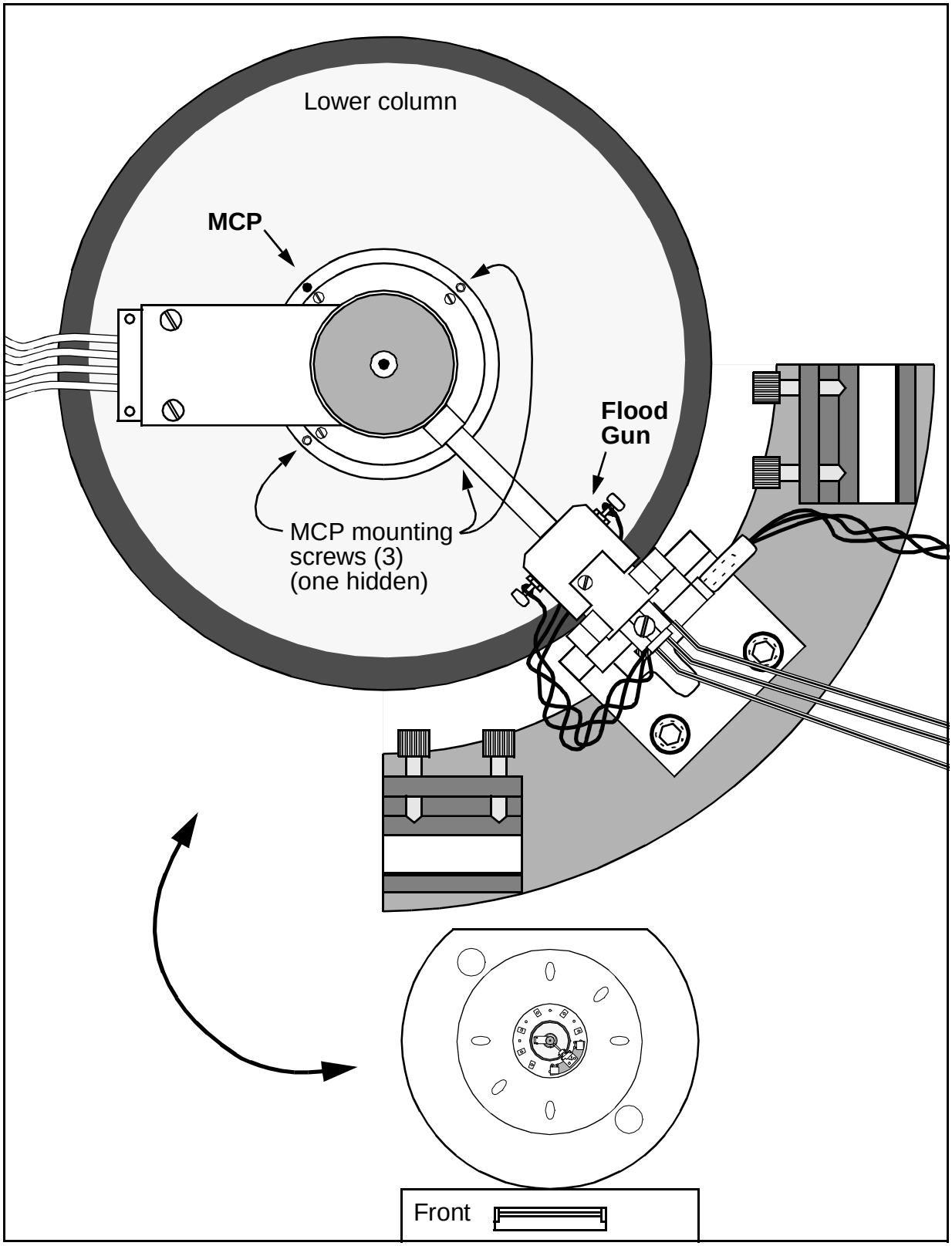


Figure 4. Flood Gun With Snout and Large MCP in 9800 System: Interior View

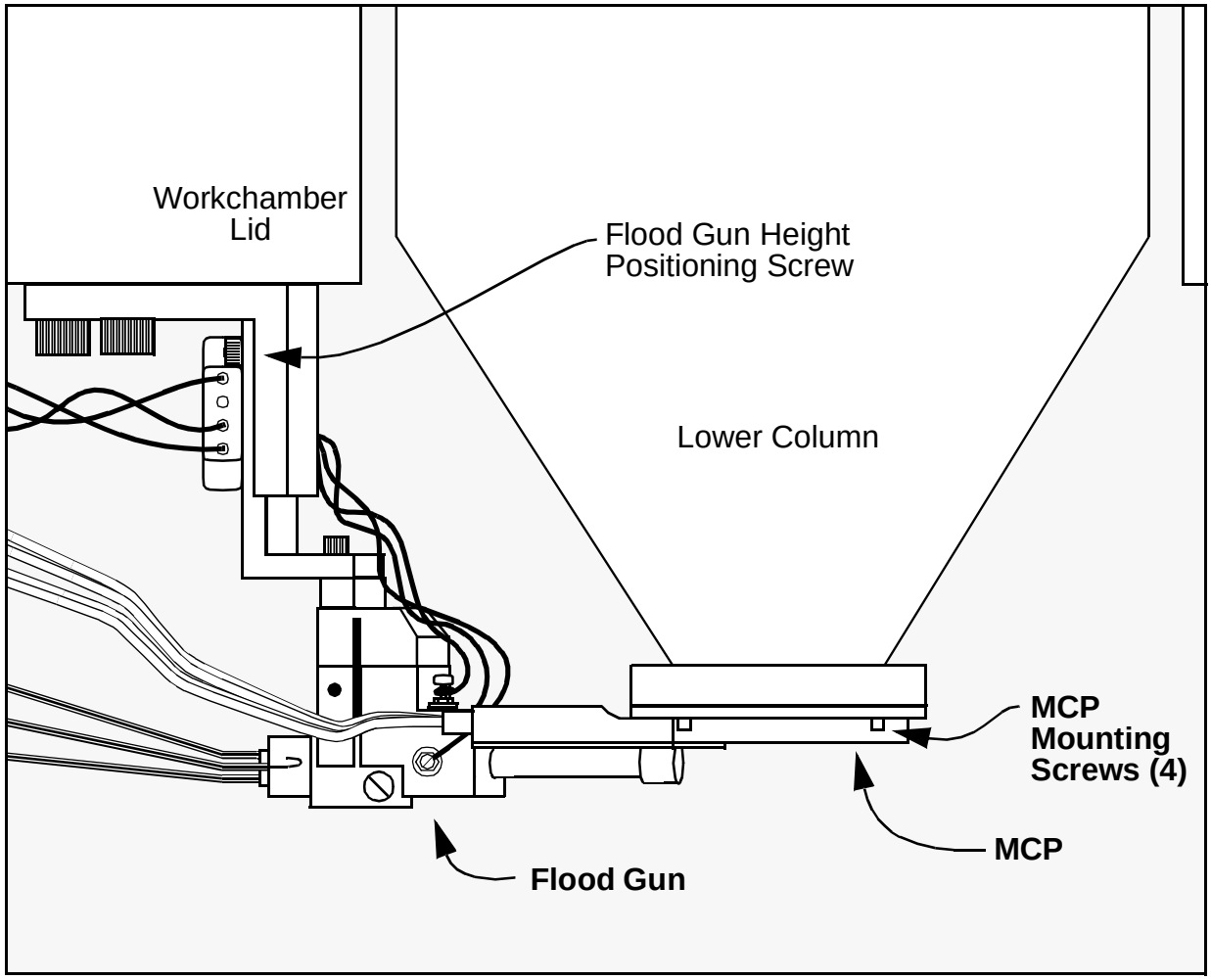


Figure 5. Side View of Flood Gun With Snout and Large MCP

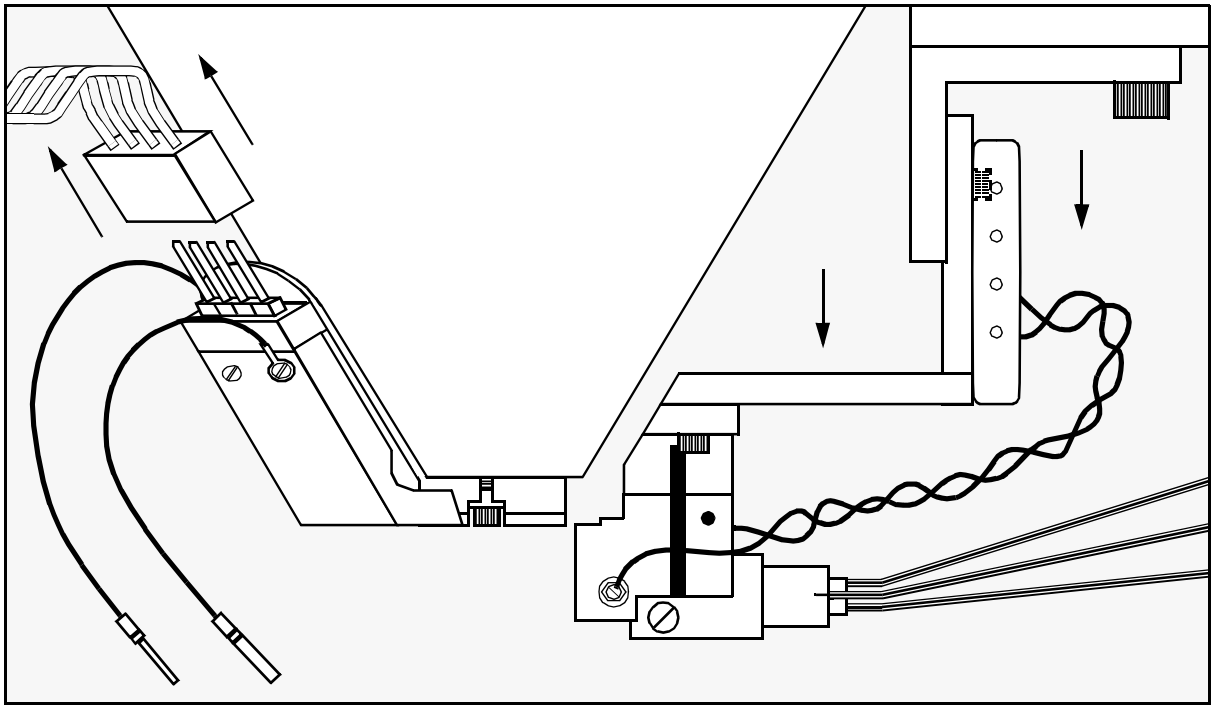


Figure 6. Side View of Flood Gun Without Snout and Small MCP: Flood Gun Lowered and MCP Disconnected.

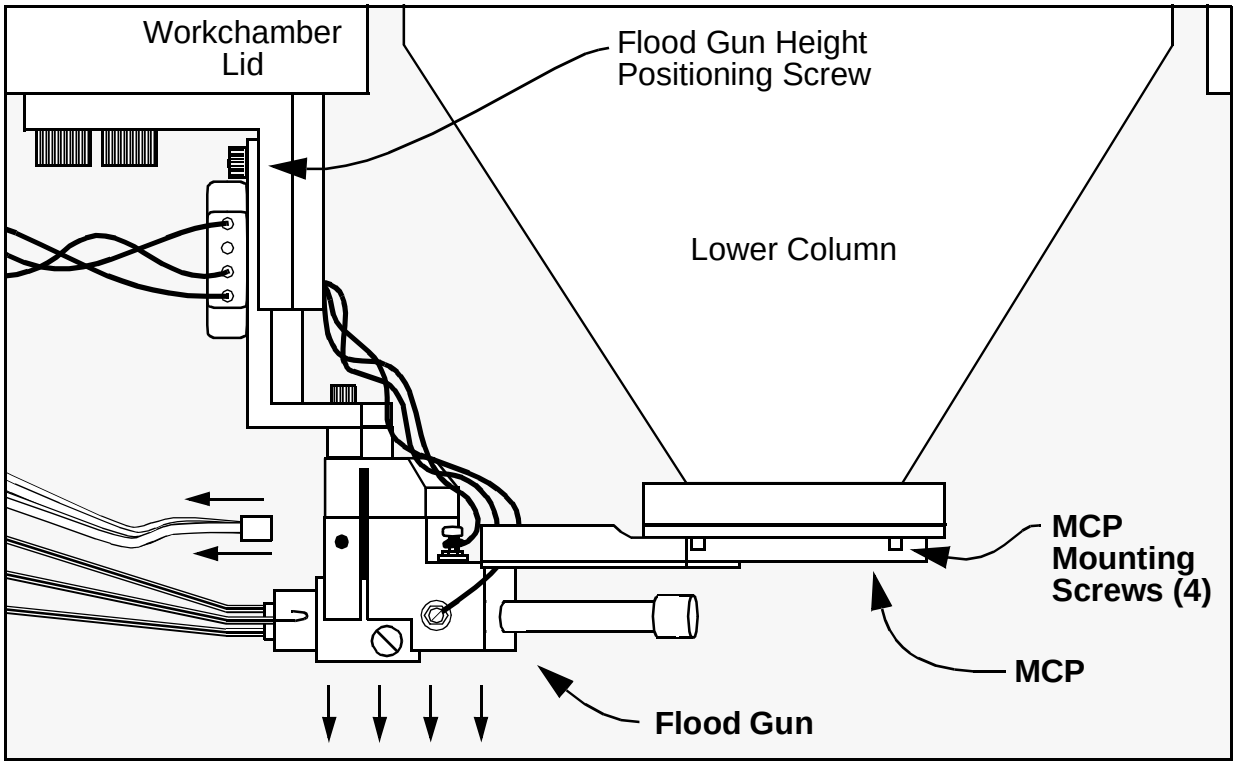


Figure 7. Side View of Flood Gun Without Snout and Small MCP: Flood Gun Lowered and MCP Disconnected.

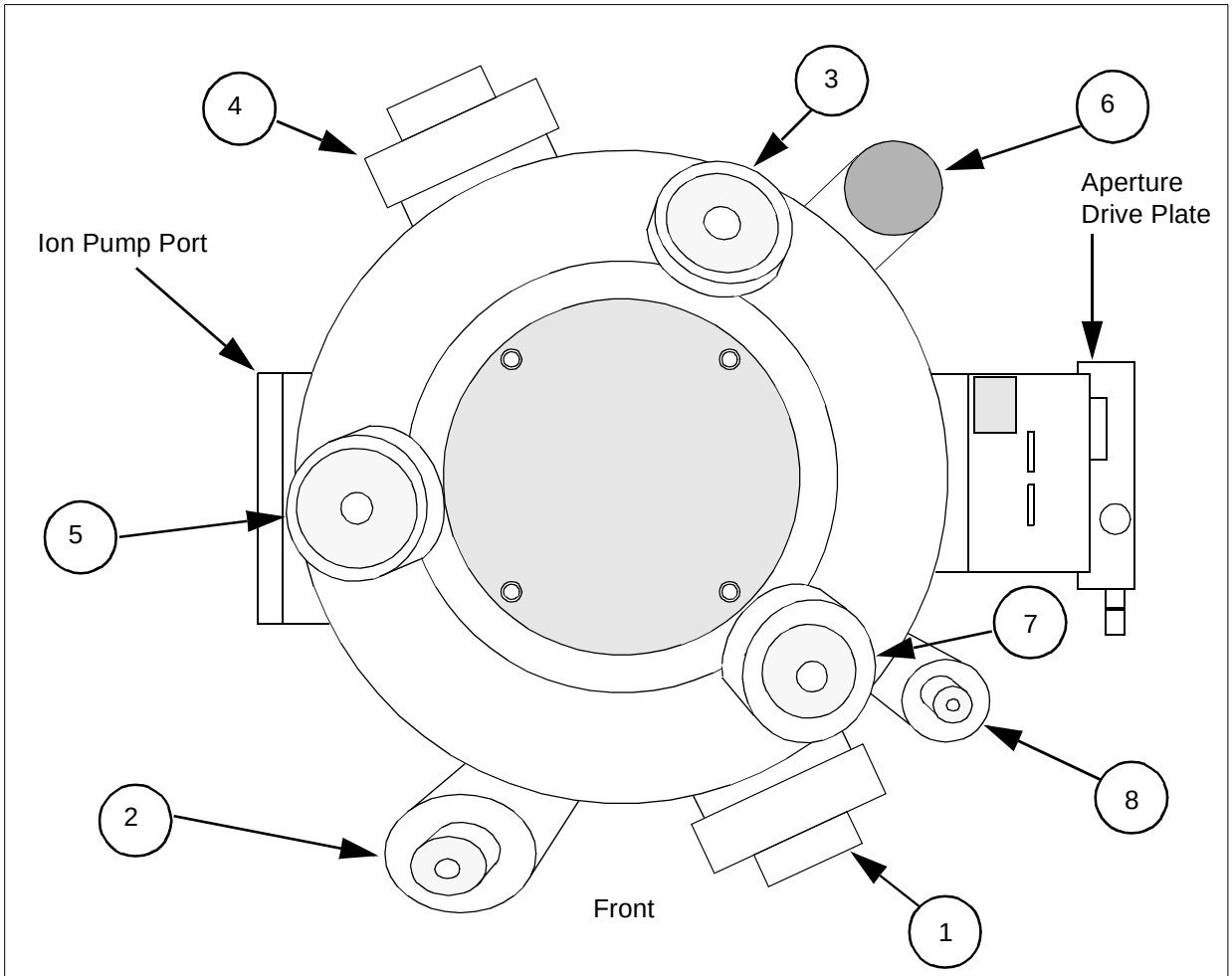


Table 1:

	Column Connections	Signal Name
1	(High Voltage)	L1 (Lens 1)
2	(High Voltage)	L2 (Lens 2)
3	(High Voltage)	S (Suppressor)
4	(High Voltage)	E (Extractor)
5	(High Voltage)	F1 (Filament)
6	(Low Voltage)	J1901 (Bbaper, octopoles)
7	(High Voltage)	F2 (Filament)
8	(Low Voltage)	Blanking Signals

Figure 8. Top View: Ion Beam Column with Power Connections

Part 3. Remove the Column Cap (Ion Gun)

3-1. Disconnect the ion pump vacuum bellows from the column.

3-2. To minimize contamination, cover the input port of the ion pump with clean aluminum foil.

3-3. Cover the ion pump port on the column with clean aluminum foil.

Double check to see that the high voltage power supply is off, then remove all high and low voltage cables (see Figure 8).

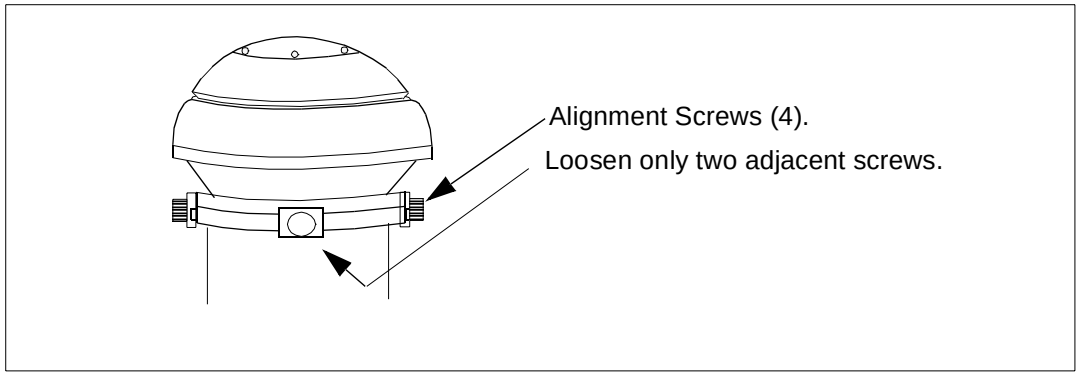


Figure 9. Location of Alignment Screws for the Column Cap Assembly.

3-4. Loosen only *two adjacent* alignment screws on the column cap (ion gun) assembly; this is done so that the ion gun alignment is minimally affected (see Figure 9).

CAUTION

Use care when lifting and moving the column cap and column housing assemblies. The column cap assembly weighs approximately 25 pounds (11 kg). The column housing weighs approximately 50 pounds (28 kg). If necessary to avoid personal injury, secure the help of another person.

3-5. For the best leverage in removing the column cap assembly, stand behind the process module. Lift the column cap assembly straight up off the column and gently place it (top side up) on a clean work surface. Immediately cover the exposed column with a clean plastic bag. **Note:** The bottom surface of the column cap assembly serves as both a registration and an O-ring surface, and is susceptible to damage from nicks and scratches.

Part 4. Remove the Column Housing

4-1. Remove the four bolts securing the column housing to the chamber. Note which holes you are removing the bolts from so that you may use the same holes when reinstalling the column (not all the holes have bolts).

NOTICE: DO NOT DAMAGE THE MCP WHEN REMOVING THE COLUMN

To avoid damage to the MCP, the column must be lifted straight out of the workchamber; this is especially important if the flat (rather than angled) style of MCP is installed on the column. Ideally, someone should guide the lower column (and MCP) out of the workchamber while the column is being lifted (assuming that the workchamber lid is propped open slightly).

4-2. Remove the column housing by lifting it straight out of the chamber, and place it upside down on a clean working surface. **Note:** The top surface of the column housing serves as a registration and a sealing surface, and is susceptible to nicks and scratches.

4-3. Cover the open column port on the process module with the appropriate cover.

4-4. Using a high-intensity light, vacuum and clean the interior of the workchamber, the ion pump tube, and the loadlock.

Part 5. Column Installation

5-1. Move all cable assemblies and vacuum bellows clear of the column port on the process module, allowing free access to the port.

CAUTION

Use care when lifting and moving the column cap and column housing assemblies. The column cap assembly weighs approximately 25 pounds (11 kg). The column housing weighs approximately 50 pounds (28 kg). If necessary to avoid personal injury, secure the help of another person.

NOTICE: DO NOT DAMAGE THE MCP DURING COLUMN INSTALLATION

To avoid damage to the MCP, the column must be lowered straight down into the workchamber port; this is especially important if the flat (rather than angled) style of MCP is installed on the column. Ideally, someone should guide the lower column (and MCP) down into the workchamber port while the column is being lowered.

5-2. Place the column housing over the port on the workchamber in the correct orientation.

5-3. Gently lower the column housing straight down into the port.

5-4. Rotate the column housing as necessary for proper alignment of the bolt holes on the column housing and the process module.

5-5. Replace the four mounting bolts in their original holes on the mounting flange.

5-6. Check the O-ring and adjacent surfaces on the top of the column housing and the bottom of the ion gun assembly for cleanliness.

5-7. Position the column cap assembly over the column and gently place it on the column housing. Rotate it as needed for proper alignment.

5-8. Tighten the two alignment screws that were initially loosened.

5-9. Making sure that the pin is centered, connect the circular connector to the Deflection input.

5-10. Connect all high voltage cables and signal cables to the column (see Figure 8).

NOTICE: AVOID BENDING PINS

Be careful when reconnecting the 3-pin and 20-pin connectors. The pins are easily bent.

5-11. Connect the vacuum bellows from the ion pump to the column.

5-12. Reattach the MCP connectors inside the chamber (see Figures 6 and 7).

5-13. Loosen the flood gun height positioning screw and slide the flood gun up until the lower portion of the flood gun assembly contacts (is flush against) the lower column (see Figure 2). If necessary, loosen the lateral positioning screws and adjust the lateral position of the flood gun to obtain a good fit against the lower column. Make sure that the flood gun is aligned with (points directly at) the center bore of the MCP (see Figures 1, 2, 3, 4, and 5).

5-14. Tighten the height (and, if used, the lateral) positioning screw(s).

5-15. Close the workchamber and pump down the system (see Service Procedure 04-03).

5-16. Enable the high voltage power supplies.

5-17. Cure the column (see Service Procedure 05-12-05).

5-18. Heat the ion source (see Service Procedure 05-11).

5-19. Calibrate the deflection control system as described in Section 7 of this manual.

Micrion

Service Procedure No.: **05-09-10**
Service Procedure Title: **Column Removal and Replacement: 10 nm Column**
Applicable Systems: **8000, Micrion 9800 FlipChip, MicroMill HT**
Frequency of Service: **As needed**

Introduction

This procedure describes the process of removing and replacing the ion beam column in the FIB system.

Materials Required

This procedure requires the use of the following materials:

- Clean, standard field service tool kit
- Lint-free wipes
- Clean-room gloves
- Laboratory-grade isopropyl alcohol
- Port blanking plates for the ion pump-column port and process module column port

NOTICE

Per paragraph 11.1 of Safety Guidelines for Semiconductor Manufacturing Equipment (S2-93), this procedure is a Type 3 task. Specifically: "Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are less than 30 volts RMS, 42.2 volts peak, 240 volt-amps, and 20 Joules."

Part1. System Preparation

Configure the Chemical Sources in "Safe" Mode

Before performing the tasks described in this procedure, you must put the chemical sources in a "safe" mode; see Service Procedure 02-01.

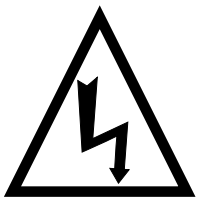
WARNING

Do not proceed until the chemical sources are secure. The chemical reservoirs in FIB systems contain hazardous materials. Labels affixed to the exterior of a chemical cabinet identify the chemical(s) contained inside. If a chemical source is not in its "safest" state, as described in **Service Procedure 02-01**, it is possible for a combination of component failures to release the chemical(s) through a cabinet's delivery line, a roughing line, a purging line, or from a chemical reservoir into the workchamber. Do not open the workchamber, or disassemble any part of the vacuum pumping system, or detach any gas line from any chemical cabinet until you are sure that every chemical source attached to the FIB system is in its "safest" state.

Power Down and Vent the System

Before performing the tasks described in this procedure, you must power down and vent the system; see Service Procedure 01-02.

WARNING



Dangerously high voltages are present in the process module while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and automatic procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

Open the Workchamber

Before opening the workchamber, clean the exterior panels.

Remove the front panels to gain access to the workchamber door.

Clean the workchamber and the loadlock exterior as described in Service Procedure 06-05.

Once the system is completely vented, open the workchamber door by removing the 1/2" socket head cap screws.

Part 2. 10 nm: Lower the Flood Gun, Remove the MCP Connectors

WEAR GLOVES, DO NOT HANDLE SOLVENTS

When working inside the chamber or when handling any components that will be exposed to vacuum, wear gloves rated for Class 100 environments or better. Due to disintegration of such gloves by solvents, do not handle solvents or parts that are wet with solvent.

2-1. After the system has vented, open the workchamber. Two types of flood gun/MCP configurations are installed in FIB systems with 10 nm columns: a flood gun without a snout combined with a small MCP[1] (as shown in Figures 1 and 2), and a flood gun with a snout paired with a large MCP[2] (as shown in Figures 3, 4, and 5).

2-2. Wearing clean room gloves, loosen the flood gun height positioning screw (see Figures 6 and 7) and slide the flood gun assembly down to provide access to the MCP.

2-3. Remove the MCP electrical connectors (see Figures 6 and 7).

[1] There are two styles of small MCP: flat and angled (see Figure 2). Both styles have the same fasteners and electrical connectors.

[2] There are two configurations of the flood gun with a snout and large MCP combination (see Figures 3 and 4). In a 9800 series system (as shown in Figure 4), the flood gun is rotated 90° to accommodate the installation of an optical microscope.

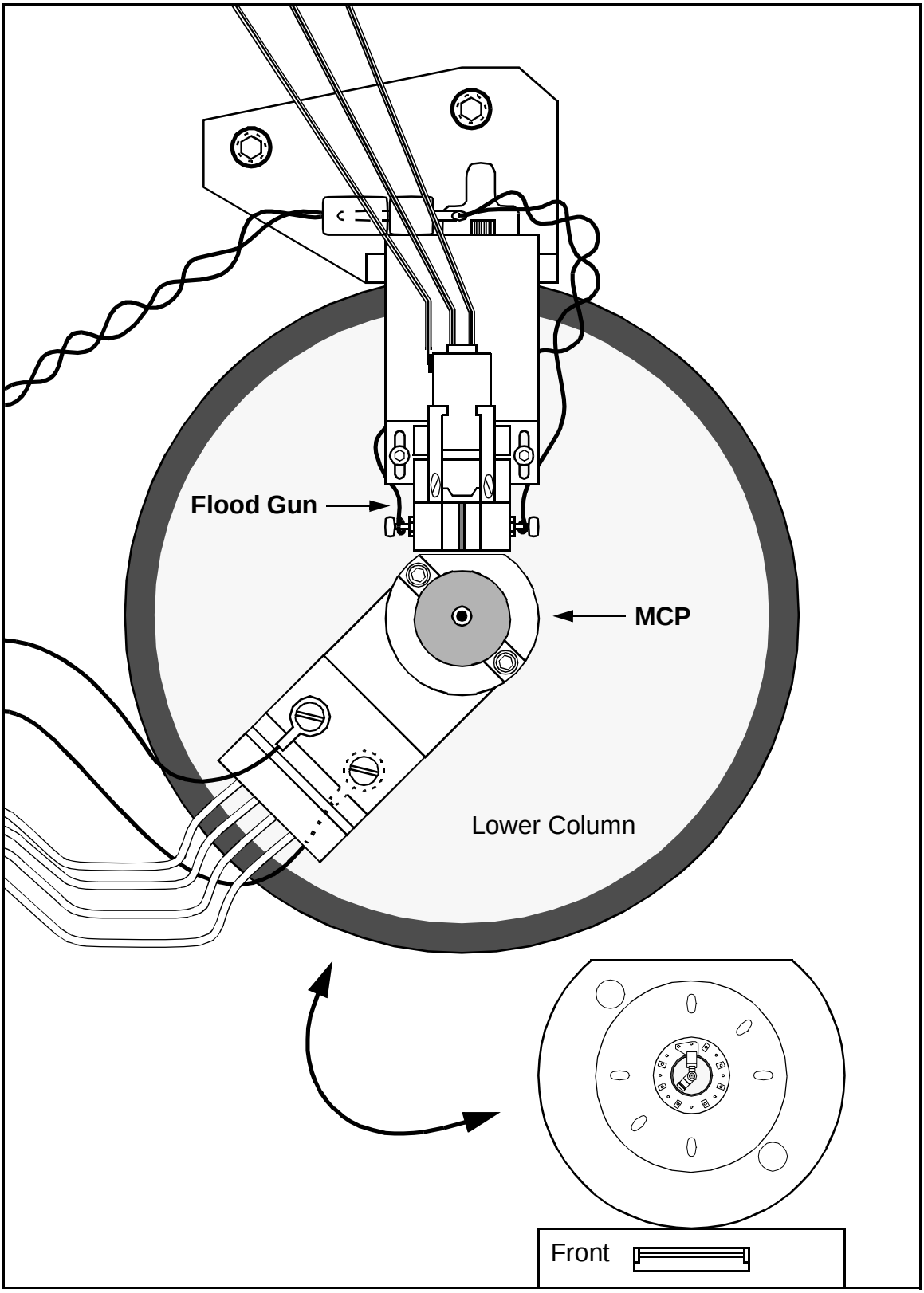


Figure 1. Flood Gun Without Snout and Small MCP: Interior View

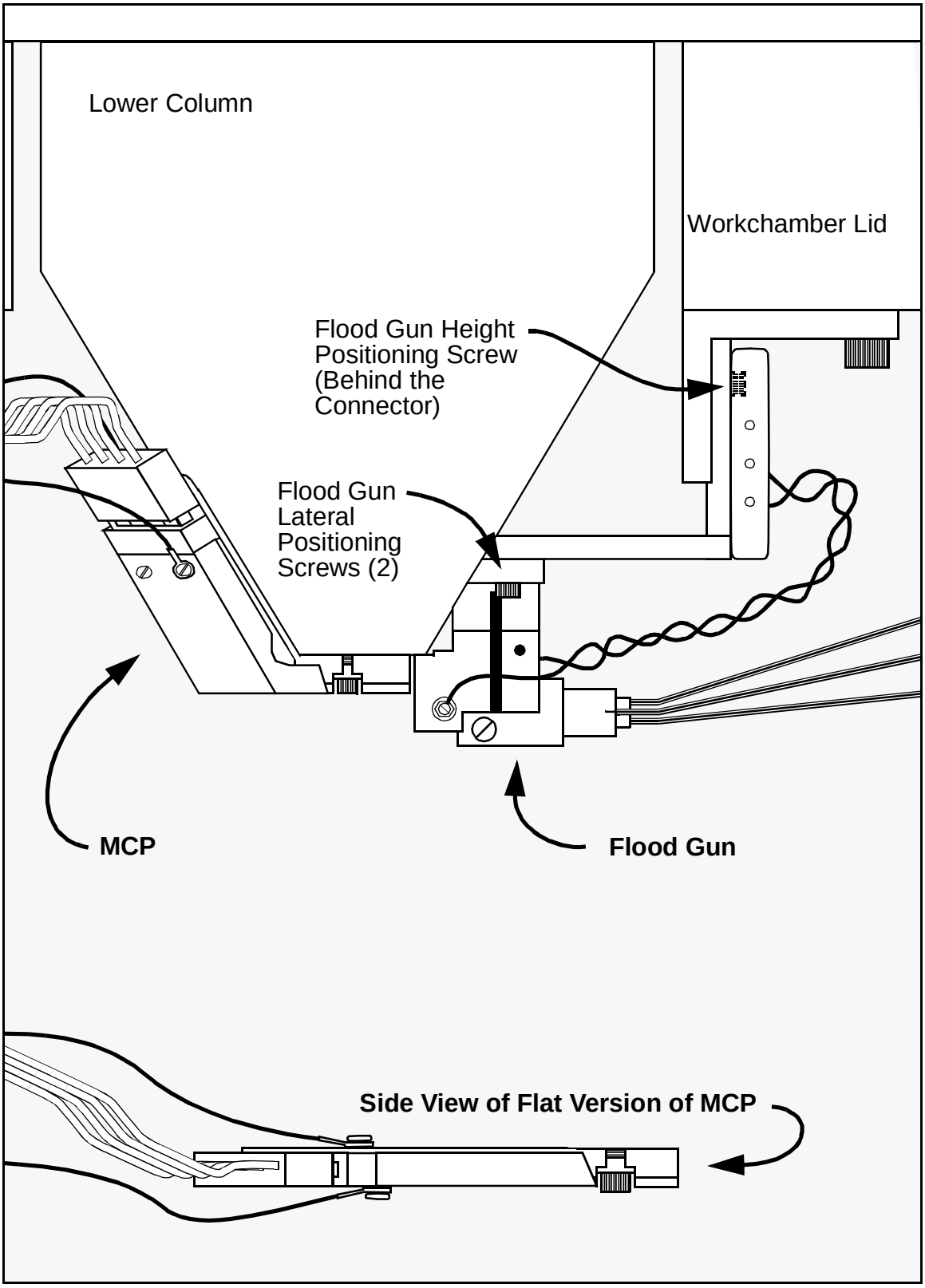

Lower Column
Workchamber Lid
Flood Gun Height Positioning Screw (Behind the Connector)
Flood Gun Lateral Positioning Screws (2)
MCP
Flood Gun
Side View of Flat Version of MCP

Figure 2. Side View of Flood Gun Without Snout and Small MCP(s)

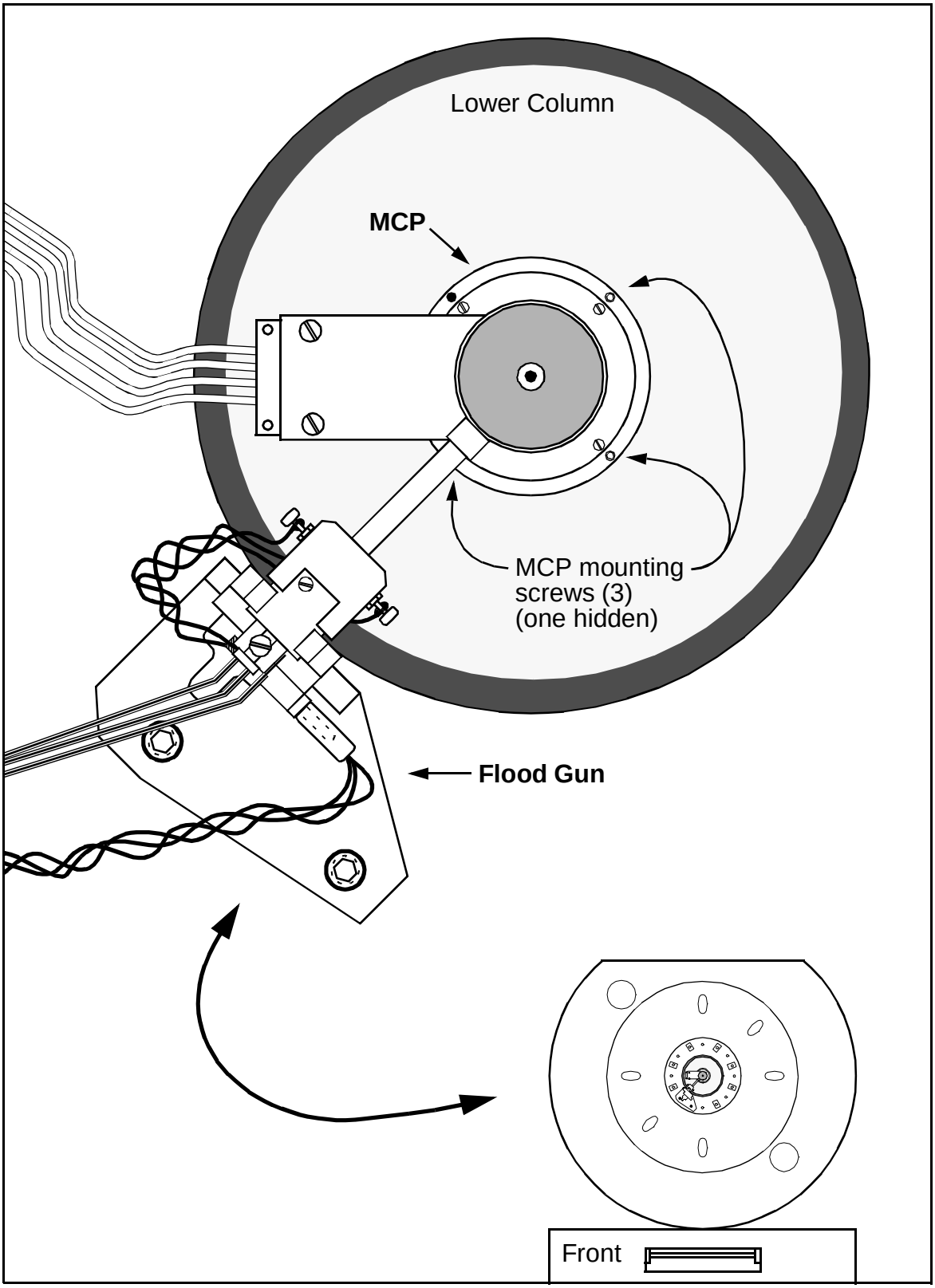


Figure 3. Flood Gun With Snout and Large MCP: Interior View

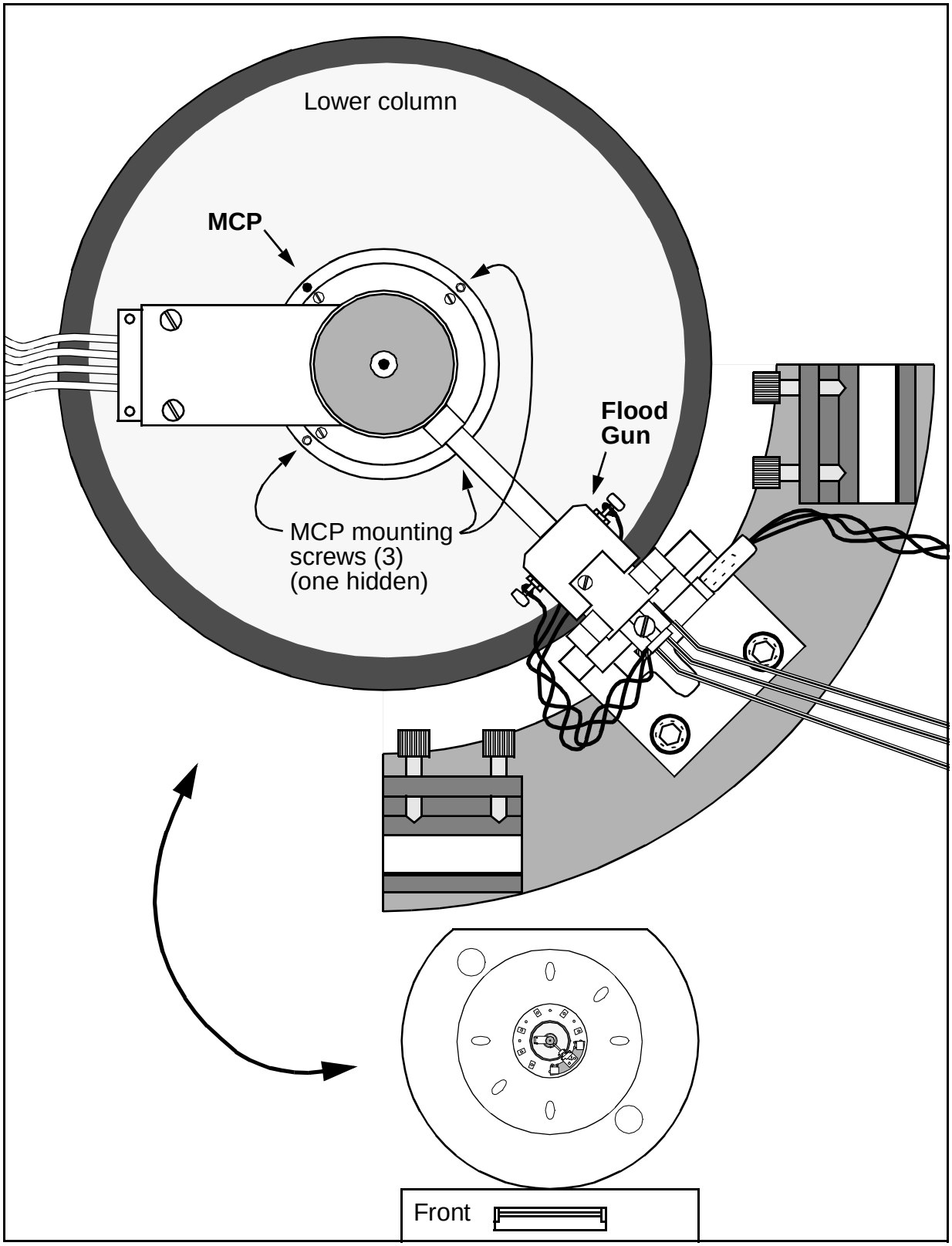


Figure 4. Flood Gun With Snout and Large MCP in 9800 System: Interior View

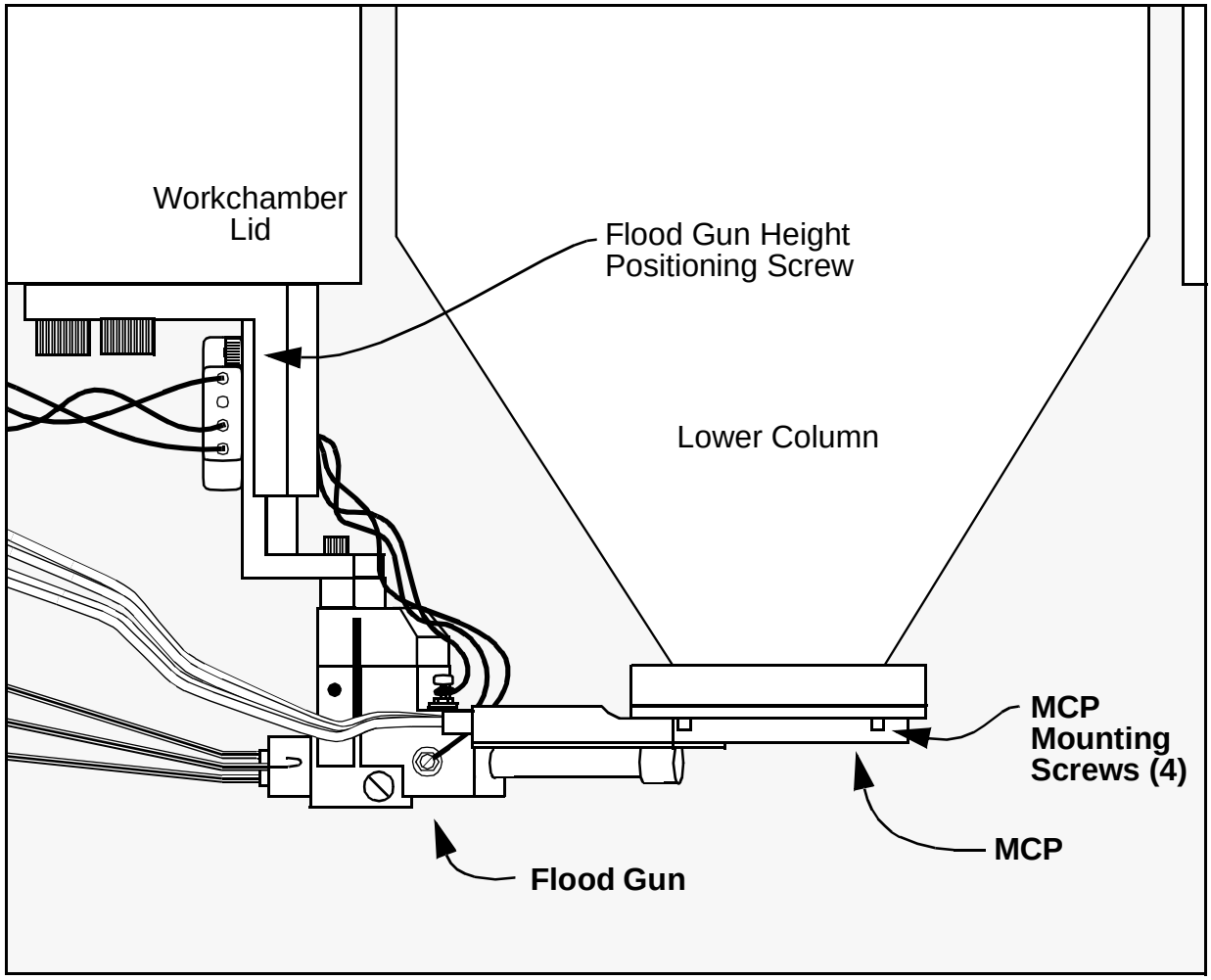


Figure 5. Side View of Flood Gun With Snout and Large MCP

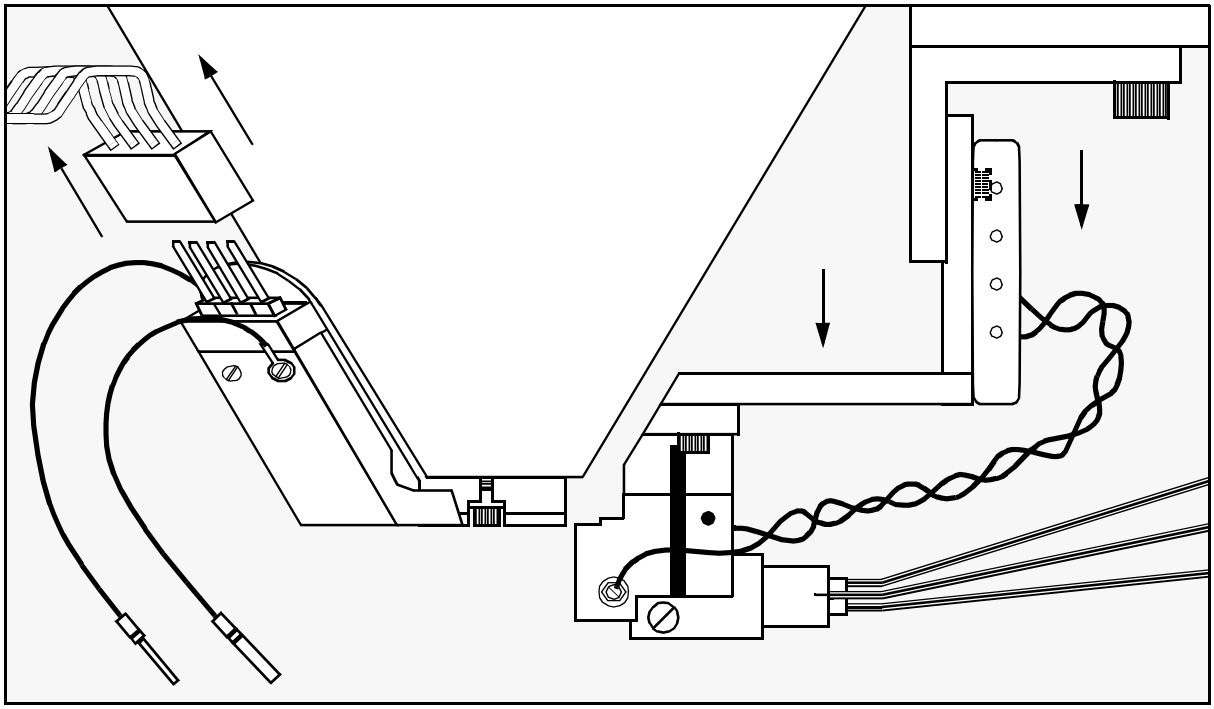


Figure 6. Side View of Flood Gun Without Snout and Small MCP: Flood Gun Lowered and MCP Disconnected.

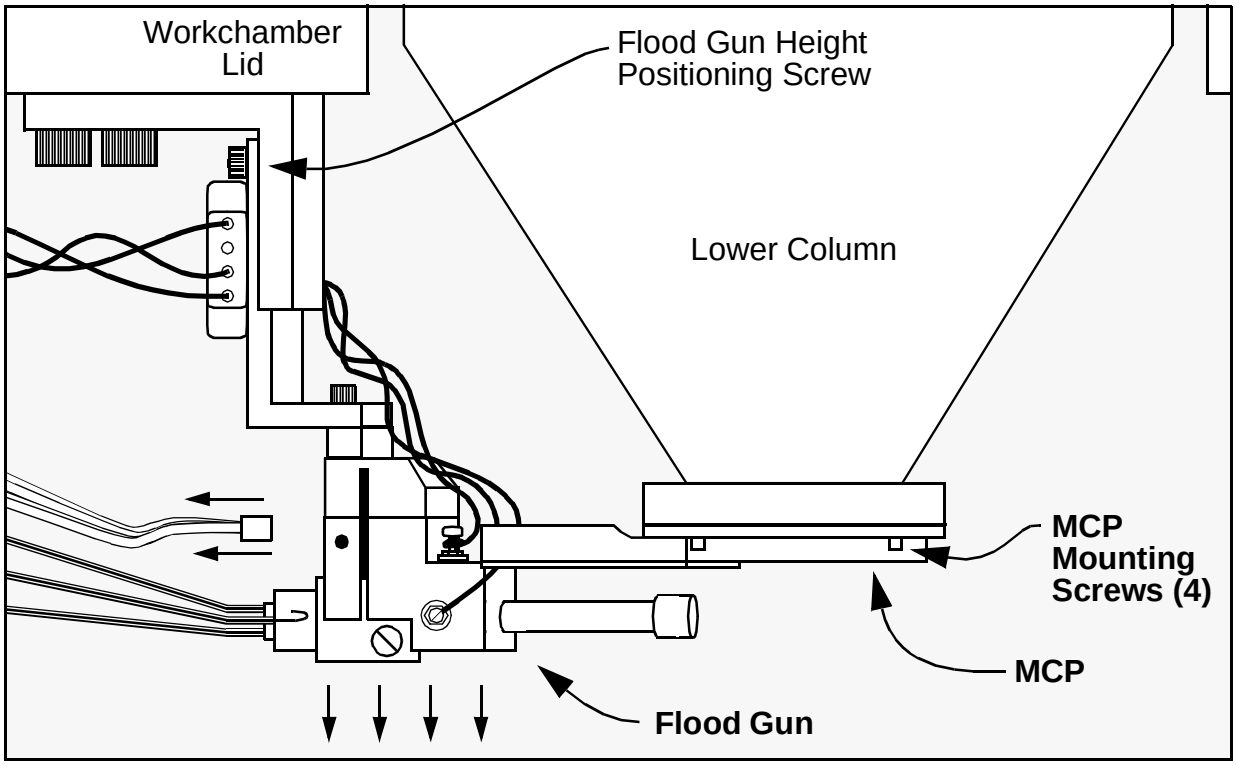


Figure 7. Side View of Flood Gun Without Snout and Small MCP: Flood Gun Lowered and MCP Disconnected.

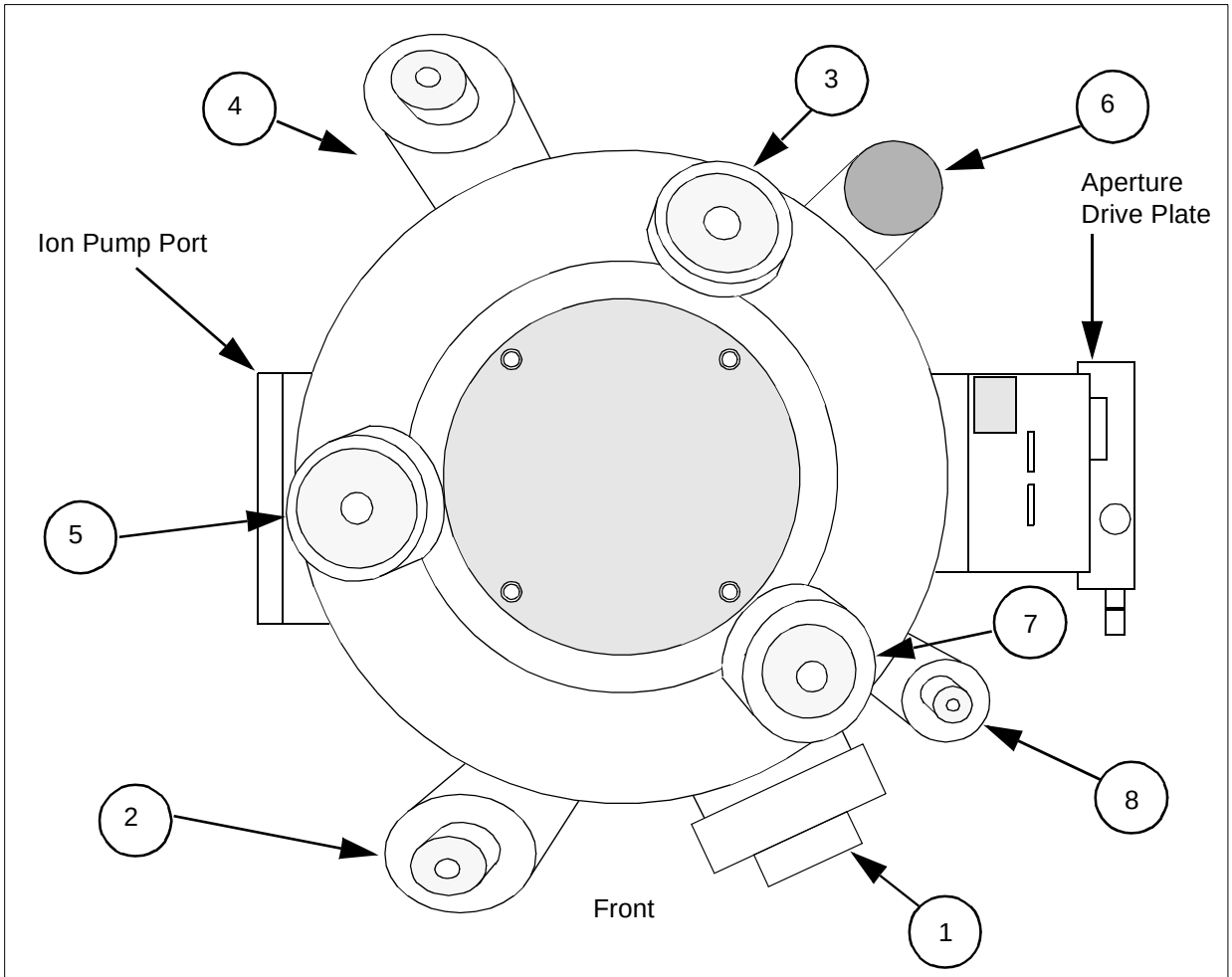


Table 1:

	Column Connections	Signal Name
1	(High Voltage)	L1 (Lens 1)
2	(High Voltage)	L2 (Lens 2)
3	(High Voltage)	F2 (Filament)
4	(High Voltage)	E (Extractor)
5	(High Voltage)	S (Suppressor)
6	(Low Voltage)	J1901 (Bbaper, octopoles)
7	(High Voltage)	F1 (Filament)
8	(Low Voltage)	Blanking Signals

Figure 8. Top View: Ion Beam Column with Power Connections

Part 3. Remove the Column Cap (Ion Gun)

3-1. Disconnect the ion pump vacuum bellows from the column.

3-2. To minimize contamination, cover the input port of the ion pump with clean aluminum foil.

3-3. Cover the ion pump port on the column with clean aluminum foil.

Double check to see that the high voltage power supply is off, then remove all high and low voltage cables (see Figure 8).

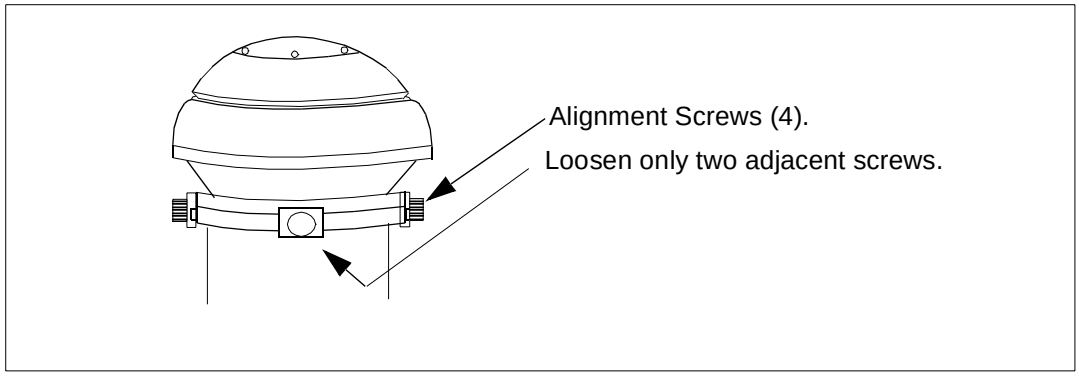


Figure 9. Location of Alignment Screws for the Column Cap Assembly.

3-4. Loosen only *two adjacent* alignment screws on the column cap (ion gun) assembly; this is done so that the ion gun alignment is minimally affected (see Figure 9).

CAUTION

Use care when lifting and moving the column cap and column housing assemblies. The column cap assembly weighs approximately 25 pounds (11 kg). The column housing weighs approximately 50 pounds (28 kg). If necessary to avoid personal injury, secure the help of another person.

3-5. For the best leverage in removing the column cap assembly, stand behind the process module. Lift the column cap assembly straight up off the column and gently place it (top side up) on a clean work surface. Immediately cover the exposed column with a clean plastic bag. **Note:** The bottom surface of the column cap assembly serves as both a registration and an O-ring surface, and is susceptible to damage from nicks and scratches.

Part 4. Remove the Column Housing

4-1. Remove the four bolts securing the column housing to the chamber. Note which holes you are removing the bolts from so that you may use the same holes when reinstalling the column (not all the holes have bolts).

NOTICE: DO NOT DAMAGE THE MCP WHEN REMOVING THE COLUMN

To avoid damage to the MCP, the column must be lifted straight out of the workchamber; this is especially important if the flat (rather than angled) style of MCP is installed on the column. Ideally, someone should guide the lower column (and MCP) out of the workchamber while the column is being lifted (assuming that the workchamber lid is propped open slightly).

4-2. Remove the column housing by lifting it straight out of the chamber, and place it upside down on a clean working surface. **Note:** The top surface of the column housing serves as a registration and a sealing surface, and is susceptible to nicks and scratches.

4-3. Cover the open column port on the process module with the appropriate cover.

4-4. Using a high-intensity light, vacuum and clean the interior of the workchamber, the ion pump tube, and the loadlock.

Part 5. Column Installation

5-1. Move all cable assemblies and vacuum bellows clear of the column port on the process module, allowing free access to the port.

CAUTION

Use care when lifting and moving the column cap and column housing assemblies. The column cap assembly weighs approximately 25 pounds (11 kg). The column housing weighs approximately 50 pounds (28 kg). If necessary to avoid personal injury, secure the help of another person.

NOTICE: DO NOT DAMAGE THE MCP DURING COLUMN INSTALLATION

To avoid damage to the MCP, the column must be lowered straight down into the workchamber port; this is especially important if the flat (rather than angled) style of MCP is installed on the column. Ideally, someone should guide the lower column (and MCP) down into the workchamber port while the column is being lowered.

5-2. Place the column housing over the port on the workchamber in the correct orientation.

5-3. Gently lower the column housing straight down into the port.

5-4. Rotate the column housing as necessary for proper alignment of the bolt holes on the column housing and the process module.

5-5. Replace the four mounting bolts in their original holes on the mounting flange.

5-6. Check the O-ring and adjacent surfaces on the top of the column housing and the bottom of the ion gun assembly for cleanliness.

5-7. Position the column cap assembly over the column and gently place it on the column housing. Rotate it as needed for proper alignment.

5-8. Tighten the two alignment screws that were initially loosened.

5-9. Making sure that the pin is centered, connect the circular connector to the Deflection input.

5-10. Connect all high voltage cables and signal cables to the column (see Figure 8).

NOTICE: AVOID BENDING PINS

Be careful when reconnecting the 3-pin and 20-pin connectors. The pins are easily bent.

5-11. Connect the vacuum bellows from the ion pump to the column.

5-12. Reattach the MCP connectors inside the chamber (see Figures 6 and 7).

5-13. Loosen the flood gun height positioning screw and slide the flood gun up until the lower portion of the flood gun assembly contacts (is flush against) the lower column (see Figure 2). If necessary, loosen the lateral positioning screws and adjust the lateral position of the flood gun to obtain a good fit against the lower column. Make sure that the flood gun is aligned with (points directly at) the center bore of the MCP (see Figures 1, 2, 3, 4, and 5).

5-14. Tighten the height (and, if used, the lateral) positioning screw(s).

5-15. Close the workchamber and pump down the system (see Service Procedure 04-03).

5-16. Enable the high voltage power supplies.

5-17. Cure the column (see Service Procedure 05-12-10).

5-18. Heat the ion source (see Service Procedure 05-11).

5-19. Calibrate the deflection control system as described in Section 7 of this manual.

Micrion

Service Procedure No.: **05-09-25**
Service Procedure Title: **Column Removal and Replacement: 25 nm Column**
Applicable Systems: **8000, Micrion 9800 FlipChip**
Frequency of Service: **As needed.**

Introduction

This procedure describes the process of removing and replacing the ion beam column in the FIB system.

Materials Required

This procedure requires the use of the following materials:

- Clean, standard field service tool kit
- Lint-free wipes
- Clean-room gloves
- Laboratory-grade isopropyl alcohol
- Port blanking plates for the ion pump-column port and process module column port

NOTICE

Per paragraph 11.1 of Safety Guidelines for Semiconductor Manufacturing Equipment (S2-93), this procedure is a Type 3 task. Specifically: "Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are less than 30 volts RMS, 42.2 volts peak, 240 volt-amps, and 20 Joules."

Part1. System Preparation

Configure the Chemical Sources in "Safe" Mode

Before performing the tasks described in this procedure, you must put the chemical sources in a "safe" mode; see Service Procedure 02-01.

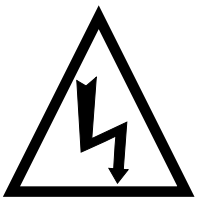
WARNING

Do not proceed until the chemical sources are secure. The chemical reservoirs in FIB systems contain hazardous materials. Labels affixed to the exterior of a chemical cabinet identify the chemical(s) contained inside. If a chemical source is not in its "safest" state, as described in **Service Procedure 02-01**, it is possible for a combination of component failures to release the chemical(s) through a cabinet's delivery line, a roughing line, a purging line, or from a chemical reservoir into the workchamber. Do not open the workchamber, or disassemble any part of the vacuum pumping system, or detach any gas line from any chemical cabinet until you are sure that every chemical source attached to the FIB system is in its "safest" state.

Power Down and Vent the System

Before performing the tasks described in this procedure, you must power down and vent the system; see Service Procedure 01-02.

WARNING



Dangerously high voltages are present in the process module while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and automatic procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

Open the Workchamber

Before opening the workchamber, clean the exterior panels.

Remove the front panels to gain access to the workchamber door.

Clean the workchamber and the loadlock exterior as described in Service Procedure 06-05.

Once the system is completely vented, open the workchamber door by removing the 1/2" socket head cap screws.

Part 2. Lower the Flood Gun, Remove the MCP Connector

2-1. After the system has vented, open the workchamber. Figures 1, 2, and 3 show the location of the flood gun and the MCP. Note that the position of the flood gun is different in a 9800 series system (as shown in Figure 2); the flood gun is rotated 90° to accommodate the installation of an optical microscope.

WEAR GLOVES, DO NOT HANDLE SOLVENTS

When working inside the chamber or when handling any components that will be exposed to vacuum, wear gloves rated for Class 100 environments or better. Due to disintegration of such gloves by solvents, do not handle solvents or parts that are wet with solvent.

2-2. Wearing clean room gloves, loosen the flood gun height positioning screw (see Figures 3 and 4). Slide the flood gun assembly down as far as it will go, then tighten the flood gun height positioning screw.

2-3. Remove the MCP electrical connector (see Figure 4).

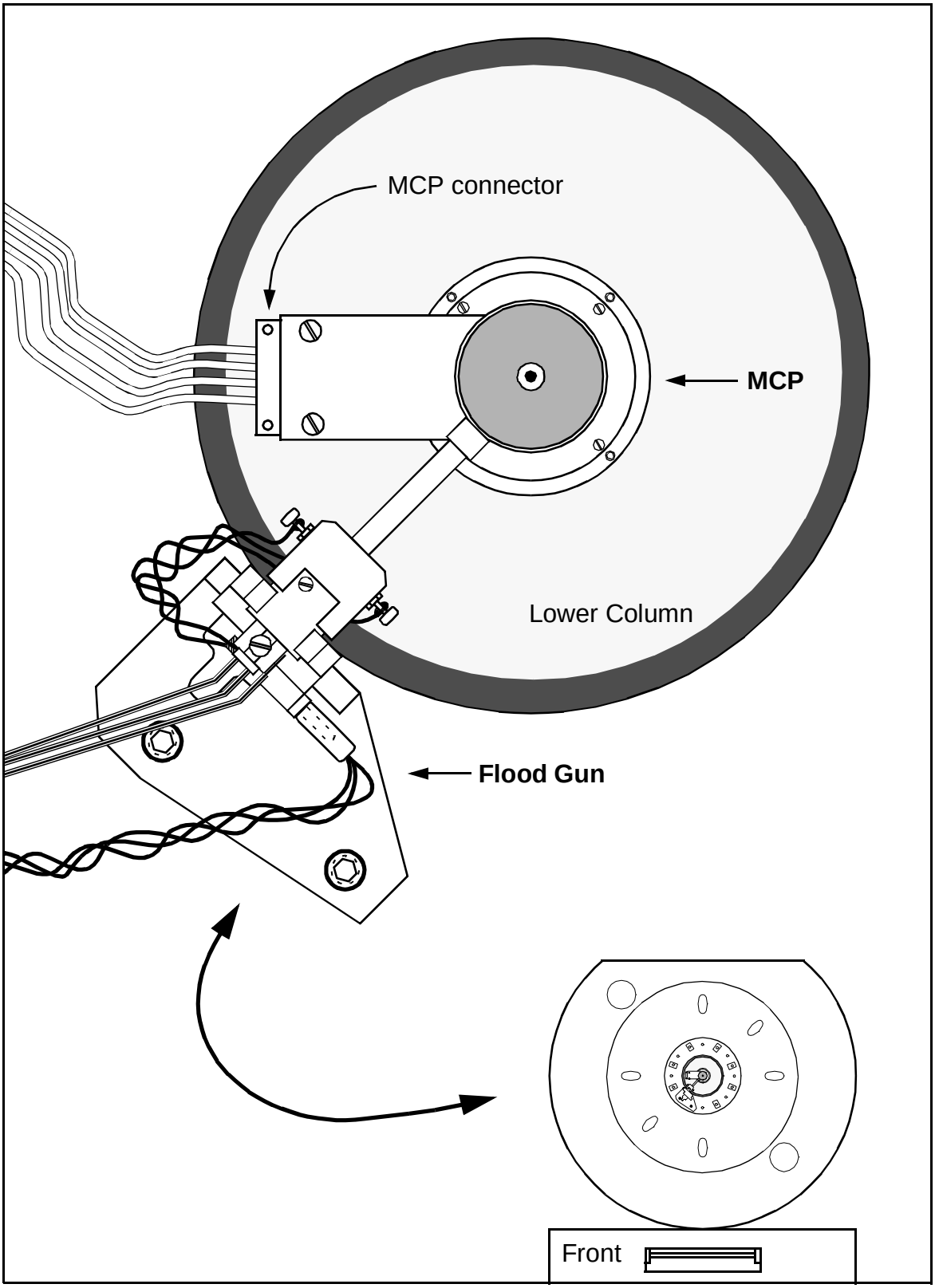


Figure 1. Interior View of Flood Gun and MCP: 25 nm Column in 8000 System

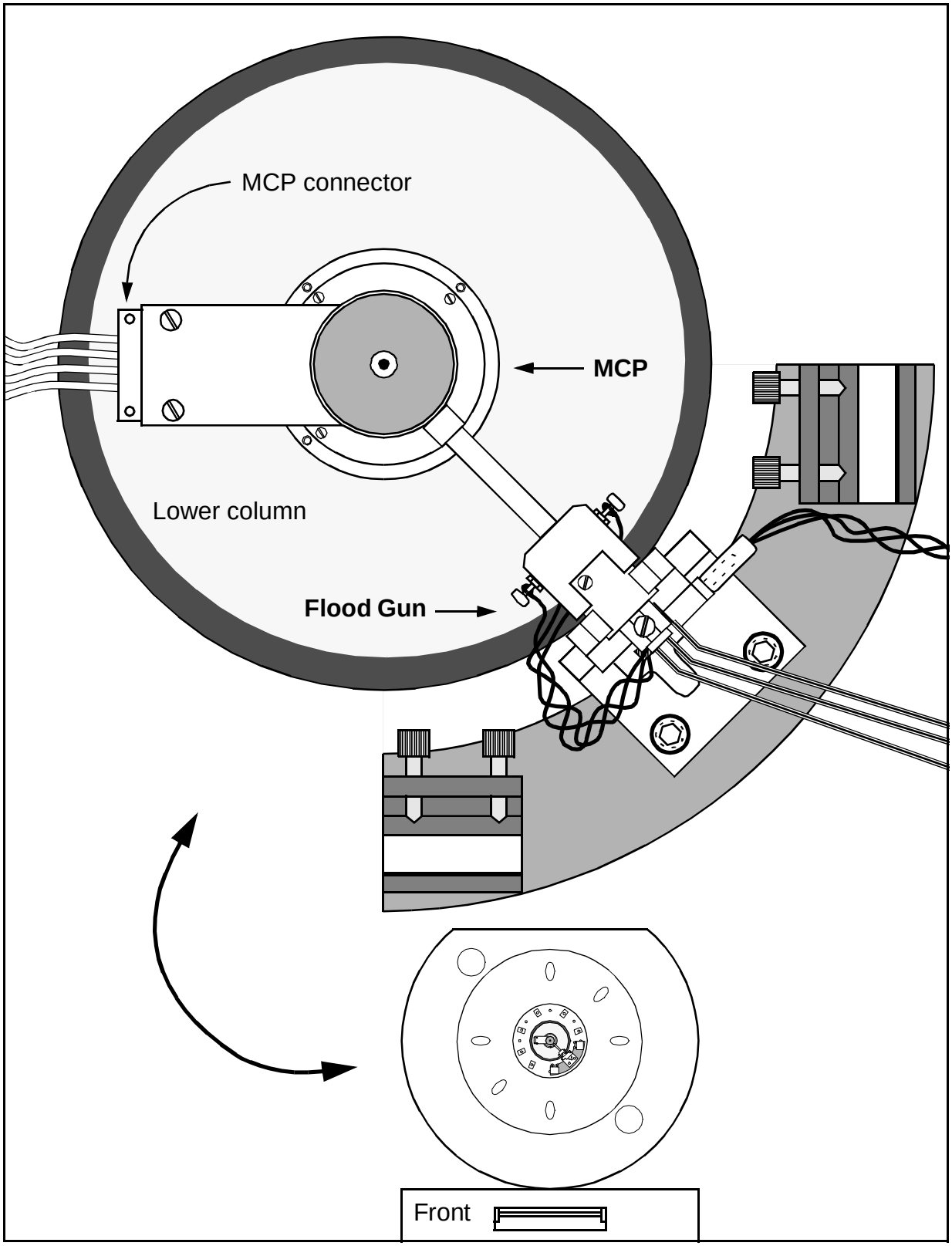


Figure 2. Interior View of Flood Gun and MCP: 25 nm Column in 9800 System

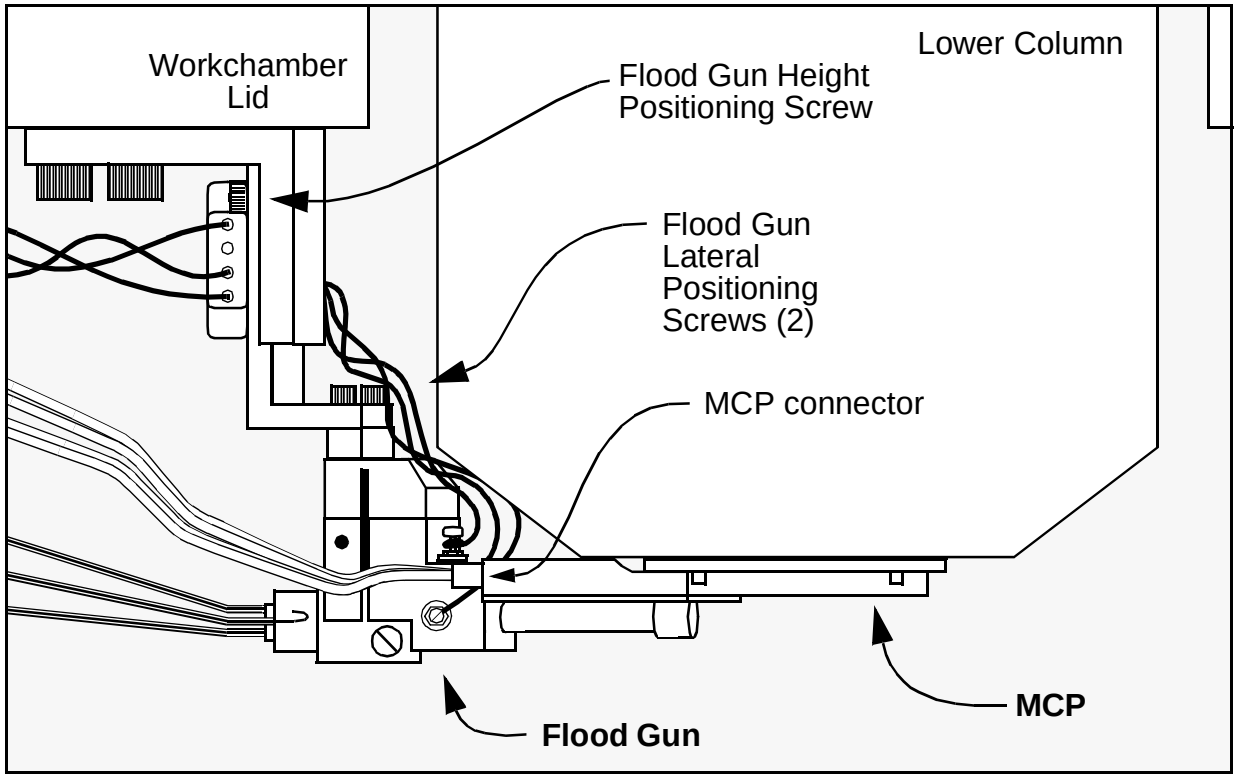


Figure 3. Side View of Flood Gun and MCP

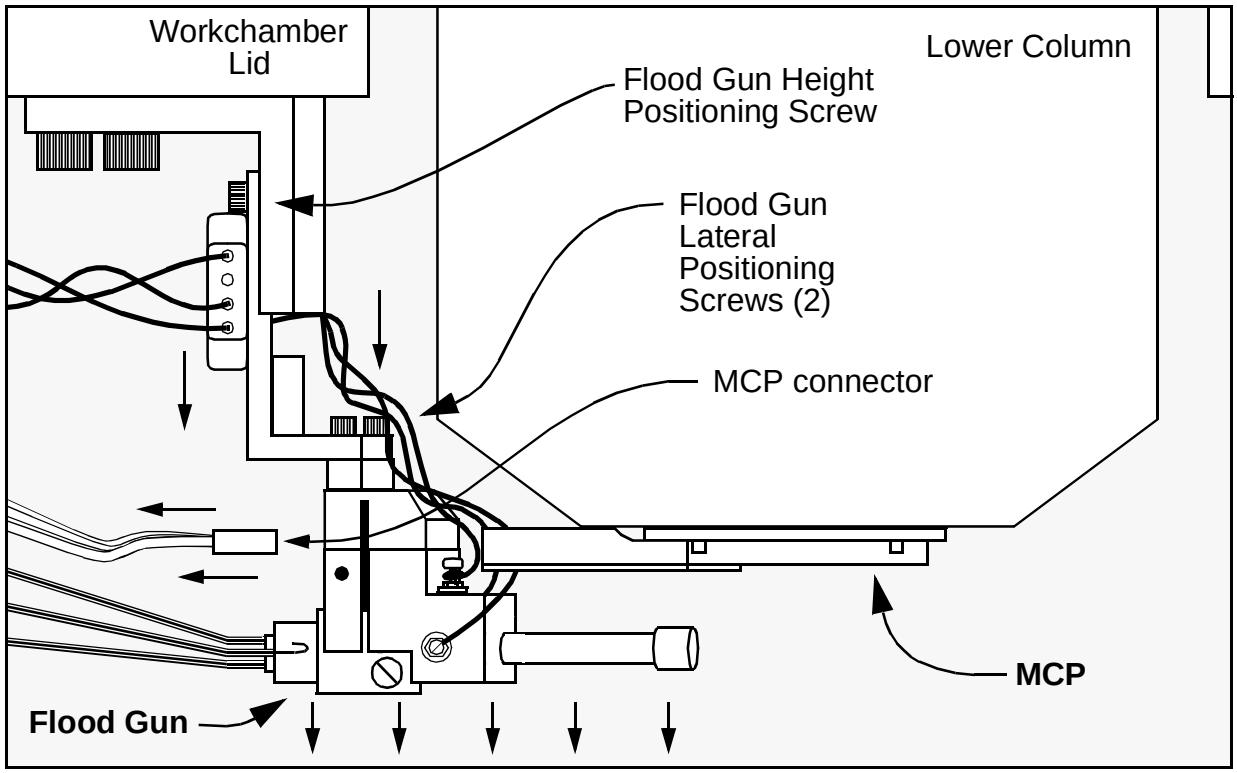


Figure 4. Flood Gun Lowered and MCP Disconnected: Side View

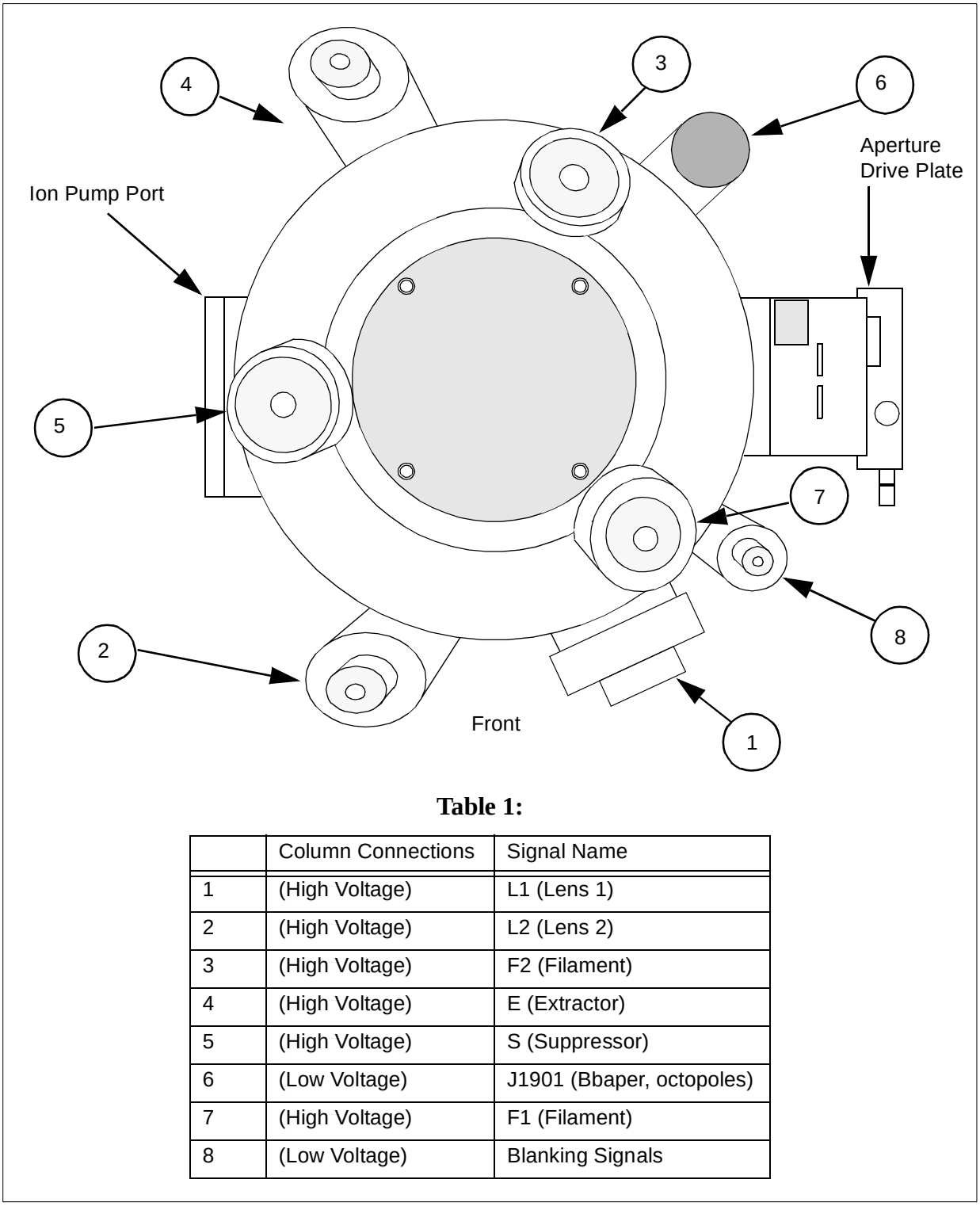


Table 1:

	Column Connections	Signal Name
1	(High Voltage)	L1 (Lens 1)
2	(High Voltage)	L2 (Lens 2)
3	(High Voltage)	F2 (Filament)
4	(High Voltage)	E (Extractor)
5	(High Voltage)	S (Suppressor)
6	(Low Voltage)	J1901 (Bbaper, octopoles)
7	(High Voltage)	F1 (Filament)
8	(Low Voltage)	Blanking Signals

Figure 5. Top View: Ion Beam Column with Power Connections

Part 3. Remove the Column Cap (Ion Gun)

3-1. Disconnect the ion pump vacuum bellows from the column.

3-2. To minimize contamination, cover the input port of the ion pump with clean aluminum foil.

3-3. Cover the ion pump port on the column with clean aluminum foil.

3-4. Double check to see that the high voltage power supply is off, then remove all high and low voltage cables (see Figure 5).

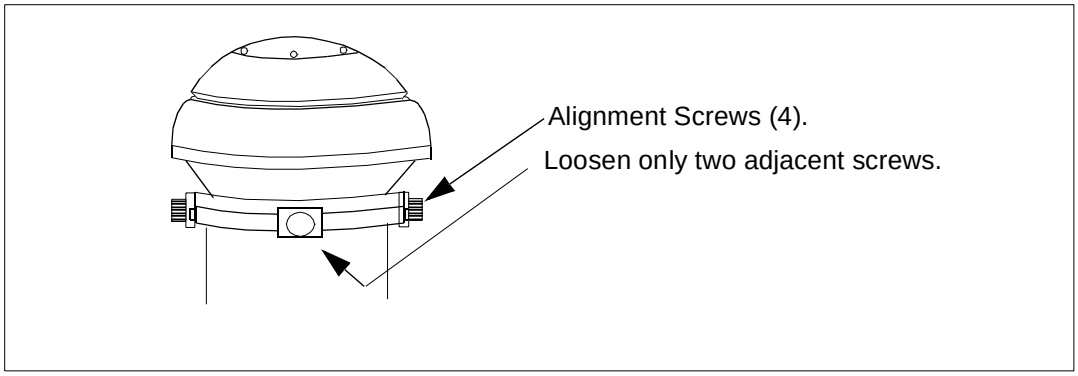


Figure 6. Location of Alignment Screws for the Column Cap Assembly.

3-5. Loosen only *two adjacent* alignment screws on the column cap (ion gun) assembly; this is done so that the ion gun alignment is minimally affected (see Figure 6).

CAUTION

Use care when lifting and moving the column cap and column housing assemblies. The column cap assembly weighs approximately 25 pounds (11 kg). The column housing weighs approximately 50 pounds (28 kg). If necessary to avoid personal injury, secure the help of another person.

3-6. For the best leverage in removing the column cap assembly, stand behind the process module. Lift the column cap assembly straight up off the column and gently place it (top side up) on a clean work surface. Immediately cover the exposed column with a clean plastic bag. **Note:** The bottom surface of the column cap assembly serves as both a registration and an O-ring surface, and is susceptible to damage from nicks and scratches.

Part 4. Remove the Column Housing

4-1. Remove the four bolts securing the column housing to the chamber. Note which holes you are removing the bolts from so that you may use the same holes when reinstalling the column (not all the holes have bolts).

NOTICE: DO NOT DAMAGE THE MCP WHEN REMOVING THE COLUMN

To avoid damage to the MCP, the column must be lifted straight out of the workchamber. Ideally, someone should guide the lower column (and MCP) out of the workchamber while the column is being lifted (assuming that the workchamber lid is propped open slightly).

4-2. Remove the column housing by lifting it straight out of the chamber, and place it upside down on a clean working surface. **Note:** The top surface of the column housing serves as a registration and a sealing surface, and is susceptible to nicks and scratches.

4-3. Cover the open column port on the process module with the appropriate cover.

4-4. Using a high-intensity light, vacuum and clean the interior of the workchamber, the ion pump tube, and the loadlock.

Part 5. Column Installation

5-1. Move all cable assemblies and vacuum bellows clear of the column port on the process module, allowing free access to the port.

CAUTION

Use care when lifting and moving the column cap and column housing assemblies. The column cap assembly weighs approximately 25 pounds (11 kg). The column housing weighs approximately 50 pounds (28 kg). If necessary to avoid personal injury, secure the help of another person.

5-2. Place the column housing over the port on the workchamber in the correct orientation.

NOTICE: DO NOT DAMAGE THE MCP DURING COLUMN INSTALLATION

To avoid damage to the MCP, the column must be lowered straight down into the workchamber port. Ideally, someone should guide the lower column (and MCP) down into the workchamber port while the column is being lowered.

5-3. Gently lower the column housing straight down into the port.

5-4. Rotate the column housing as necessary for proper alignment of the bolt holes on the column housing and the process module.

5-5. Replace the four mounting bolts in their original holes on the mounting flange.

5-6. Check the O-ring and adjacent surfaces on the top of the column housing and the bottom of the ion gun assembly for cleanliness.

5-7. Position the column cap assembly over the column and gently place it on the column housing. Rotate it as needed for proper alignment.

5-8. Tighten the two alignment screws that were initially loosened.

5-9. Making sure that the pin is centered, connect the circular connector to the Deflection input.

5-10. Connect all high voltage cables and signal cables to the column (see Figure 5).

NOTICE: AVOID BENDING PINS

Be careful when reconnecting the 3-pin and 20-pin connectors. The pins are easily bent.

5-11. Connect the vacuum bellows from the ion pump to the column.

5-12. Reattach the MCP connectors inside the chamber (see Figures 1, 2, and 3).

5-13. Loosen the height adjustment screw and slide the flood gun up until the end of the flood gun snout contacts the MCP as shown in Figures 1, 2, and 3. Be careful not to damage the MCP screen. Make sure that the flood gun snout is aligned with (points directly at) the center bore of the MCP (see Figures 1 and 2). If necessary, loosen the lateral positioning screws and adjust the lateral position of the flood gun to obtain the proper orientation against the MCP.

5-14. Tighten the height (and, if used, the lateral) adjustment screw(s).

5-15. Close the workchamber and pump down the system (see Service Procedure 04-03).

5-16. Enable the high voltage power supplies.

5-17. Cure the column (see Service Procedure 05-12-25).

5-18. Heat the ion source (see Service Procedure 05-11).

5-19. Calibrate the deflection control system as described in Section 7 of this manual.

Micrion

Service Procedure No.: **05-10**

(Has thin film of Braycote 803.)

Service Procedure Title: **Ion Source Change**
Applicable Systems: **All**

Frequency of Service: **As Needed**

Introduction

Lifetime of a liquid metal gallium source (p/n 110-000740) is determined by two factors:

- Extraction current
- Frequency and length of source heating

This procedure describes how to determine the number of hours a source has been used, how to change a source, and how to register that new source in the log.

NOTICE:

Per paragraph 11.1 of *Safety Guidelines for Semiconductor Manufacturing Equipment* (S2-93), this procedure is a Type 3 task. Specifically: "Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are less than 30 volts RMS, 42.2 volts peak, 240 volt-amps, and 20 Joules."

Required Materials

This procedure requires the following materials:

- Gallium liquid metal ion source, Micrion part no. 110-000740
- Spare suppressor cap supplied with every system (which can be pre-loaded with a source to reduce the time that the system is vented)
- Standard field service toolkit
- Column service kit, Micrion part no. 100-007380 (shipped with system)
- Clean room with laminar flow hood
- Source of filtered dry nitrogen or filtered dry pressurized air
- Lint-free clean-room wipes
- 6-inch cotton tipped applicators
- Clean-room gloves
- Laboratory grade detergent
- Laboratory grade isopropyl alcohol or equivalent solvent
- Small beaker
- Ultrasonic cleaner
- High-intensity light

Part 1. Determine the Hours of Service on a Source

Using the log_main program, determine the number of hours on the current source. To gain access to this program, press the right mouse button and select `log_main` from the menu, or type `log_main` at the prompt in any xterm window.

In the log_main window, select Ion Source from the choices in the Device menu button to display information about the source.

Part 2. System Preparation

Configure the Chemical Sources in “Safe” Mode

Before performing the tasks described in this procedure, you must put the chemical sources in a “safe” mode; see Service Procedure 02-01.

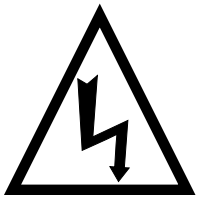
WARNING

Do not proceed until the chemical sources are secure. The chemical reservoirs in FIB systems contain hazardous materials. Labels affixed to the exterior of a chemical cabinet identify the chemical(s) contained inside. If a chemical source is not in its "safest" state, as described in **Service Procedure 02-01**, it is possible for a combination of component failures to release the chemical(s) through a cabinet's delivery line, a roughing line, a purging line, or from the tungsten reservoir into the workchamber. Do not open the workchamber, or disassemble any part of the vacuum pumping system, or detach any gas line from any chemical cabinet until you are sure that every chemical source attached to the FIB system is in its "safest" state.

Power Down and Vent the System

Before performing the tasks described in this procedure, you must power down and vent the system; see Service Procedure 01-02.

WARNING



Dangerously high voltages are present in the process module while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and auto procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

Part 3. Prepare a Clean Work Surface

Column assembly components are very sensitive to particulate contamination. You must have a very clean area to perform this procedure. The ideal location is under a laminar flow hood.

Clear a flat surface large enough to perform this procedure. Use a clean room vacuum cleaner to remove dust and other particulates.

Clean off the system and the column as described in Service Procedure 06-05.

Part 4. Remove the Ion Gun Assembly

After you have shut off all high voltages and vented the system, begin removing the old ion source.

WEAR GLOVES, DO NOT HANDLE SOLVENTS

When working inside the chamber or when handling any components that will be exposed to vacuum, wear gloves rated for Class 100 environments or better. Due to disintegration of such gloves by solvents, do not handle solvents or parts that are wet with solvent.

4-1. With a 3/32" Allen wrench, loosen the four captive socket-head screws on the top of the column cap assembly, as shown in Figure 1.

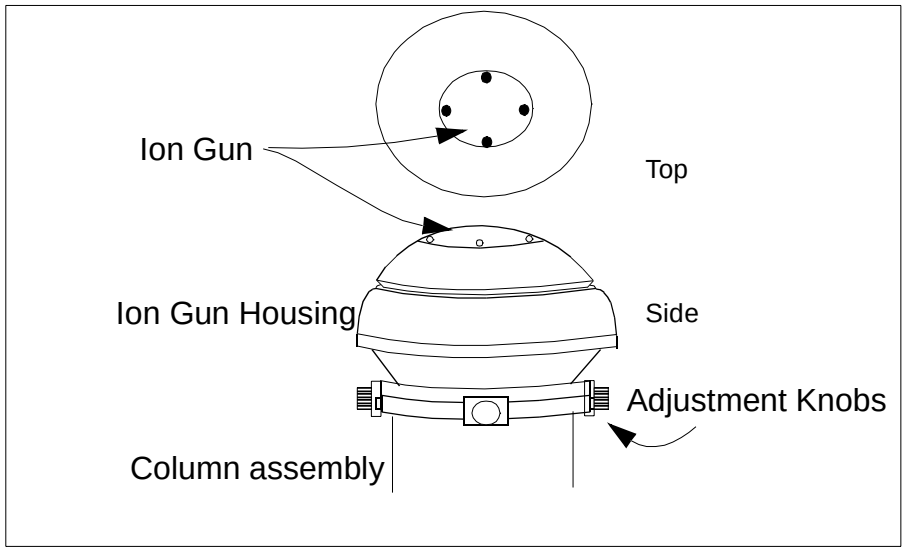


Figure 1. Ion Gun Housing: Top and Side Views

4-2. Remove the ion gun assembly. Unscrew ("back-out") the four captive socket-head screws until they protrude from the ion gun assembly; the screws will act as legs to stabilize the ion gun assembly (see Figure 2). Place the ion gun assembly upside down on a work surface, as shown in Figure 2. **Do not scrape or mar the ceramic insulator or touch it with bare hands.**

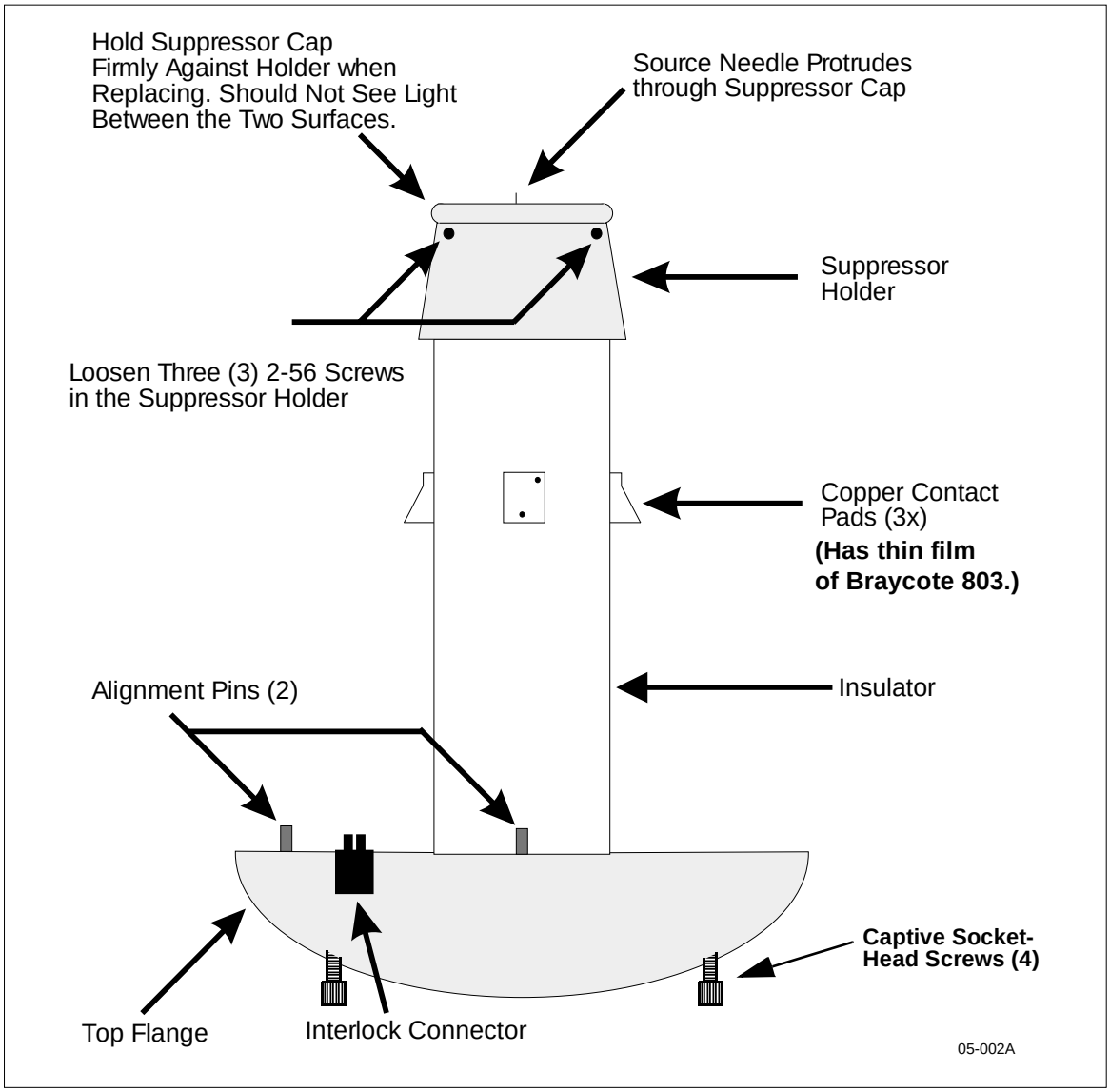

Hold Suppressor Cap Firmly Against Holder when Replacing. Should Not See Light Between the Two Surfaces.
Source Needle Protrudes through Suppressor Cap
Suppressor Holder
Loosen Three (3) 2-56 Screws in the Suppressor Holder
Copper Contact Pads (3x)
(Has thin film of Braycote 803.)
Alignment Pins (2)
Insulator
Captive Socket-Head Screws (4)
Top Flange
Interlock Connector
05-002A

Figure 2. The Ion Gun Assembly

4-3. Clean the ion gun assembly with lint free wipes and dry nitrogen.

4-4. Inspect the O-ring and mating surface to make sure that they are clean and free of scratches. Clean them if necessary.

Part 5. Remove the Spent Source/Suppressor Assembly

5-1. Use a 0.035" Allen wrench to loosen the three 2-56 socket-head screws in the side of the suppressor holder (see Figure 2). Carefully remove the suppressor cap. Hold the suppressor cap steady with thumb and forefinger while loosening the screws.

5-2. Use a screwdriver and tweezers to loosen the two screws holding the source clamps (see Figure 3).

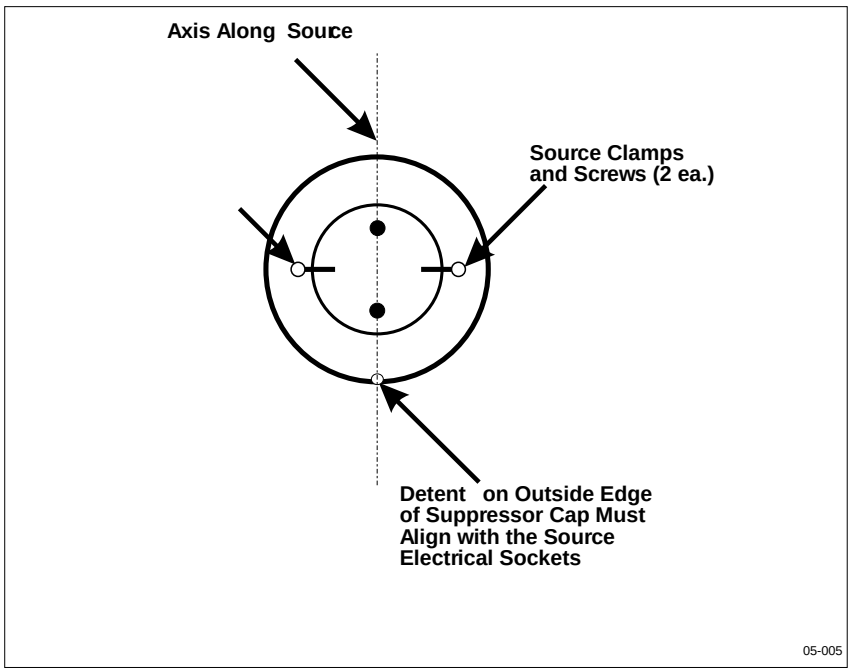


Figure 3. Alignment of Suppressor Cap and Source

5-3. Release the source clamps from the source by rotating them out to the side.

5-4. Use tweezers to remove the ion source from the suppressor cap.

5-5. After it is removed from the FIB system, the spent source should be returned to Micrion if necessary for analysis; otherwise it should be packaged for proper disposal according to local, state, and federal EPA regulations.

Part 6. Install a Pre-Loaded Source/Suppressor Assembly

CAUTION

The FIB ion source is a coating of liquid gallium on a fine wire filament. The tip of the wire filament is extremely sharp and, if mishandled, can puncture the skin and introduce gallium subcutaneously.

6-1. Place the pre-loaded source/suppressor assembly on the ion gun.

6-2. Align the suppressor cap with the suppressor holder so that the source electrical connector pins are correctly aligned with the sockets of the suppressor holder. See Figure 3.

6-3. Install the suppressor cap so that the electrical connector pins become inserted in the sockets in the suppressor holder.

6-4. Firmly hold the cap flush against the holder while tightening the three 2-56 screws. These two surfaces are designed to a flatness specification. When installed properly, there should be no light seen between the cap and the holder. See Figure 2.

Part 7. Reinstall the Ion Gun Assembly, Pump Down the System

NOTICE: ALIGNMENT PINS MUST MATCH MATING HOLES

The contact springs attached to the copper contact pads on the insulator (see Figure 2) can be bent if the ion gun is rotated while being inserted. Line up the alignment pins with the mating holes on the column before inserting the ion gun. The pins must be aligned **before** the ion gun is inserted half-way. It is critical not to rotate the gun during the last 1 inch of insertion.

7-1. Make sure that you properly align the pins in the flange of the ion gun assembly with the receptacles in the ion source head. Figure 2 shows the location of the alignment pins. Place the ion gun assembly on the column.

7-2. Fasten the ion gun to the column with the four captive socket-head screws as shown in Figure 1.

7-3. Pump down the system as described in Service Procedure 04-03.

Part 8. Register the New Source in log_main, Power Up the System

Register the new source in the log_main program so that its usage will be recorded. The ion source is considered "in use" when the acceleration voltage is enabled and there is at least 0.25 mA of extraction current.

8-1. Type `log_main` in an xterm window to open the log file utility window (Figure 4). Select Source on the *Device* option button to display information about the source.

8-2. Click on the *New* button to display the *Newlog* popup window as shown in Figure 4.

8-3. In the Newlog popup, enter the serial number of the new source, and click on the *Today* button to set the current day as the installation date for the source.

8-4. Click on *OK* in the Newlog popup, and click on *Quit* in the LogFile Utility popup.

NOTICE

The logging function will not log the new source unless you restart the software (as described below) after creating a new log file.

8-5. To activate the registration of the new source, click the *Quit & Exit* button in the Process Watcher popup. At the command shell prompt, enter

```
xinit ↵
```

to restart the X window system.

8-6. Power up the system as described in Service Procedure 01-01.

8-7. Cure the column (see Service Procedure 05-12-05).

8-8. Heat the ion source (see Service Procedure 05-11).

Calibrate the deflection control system as described in Section 7 of this manual.

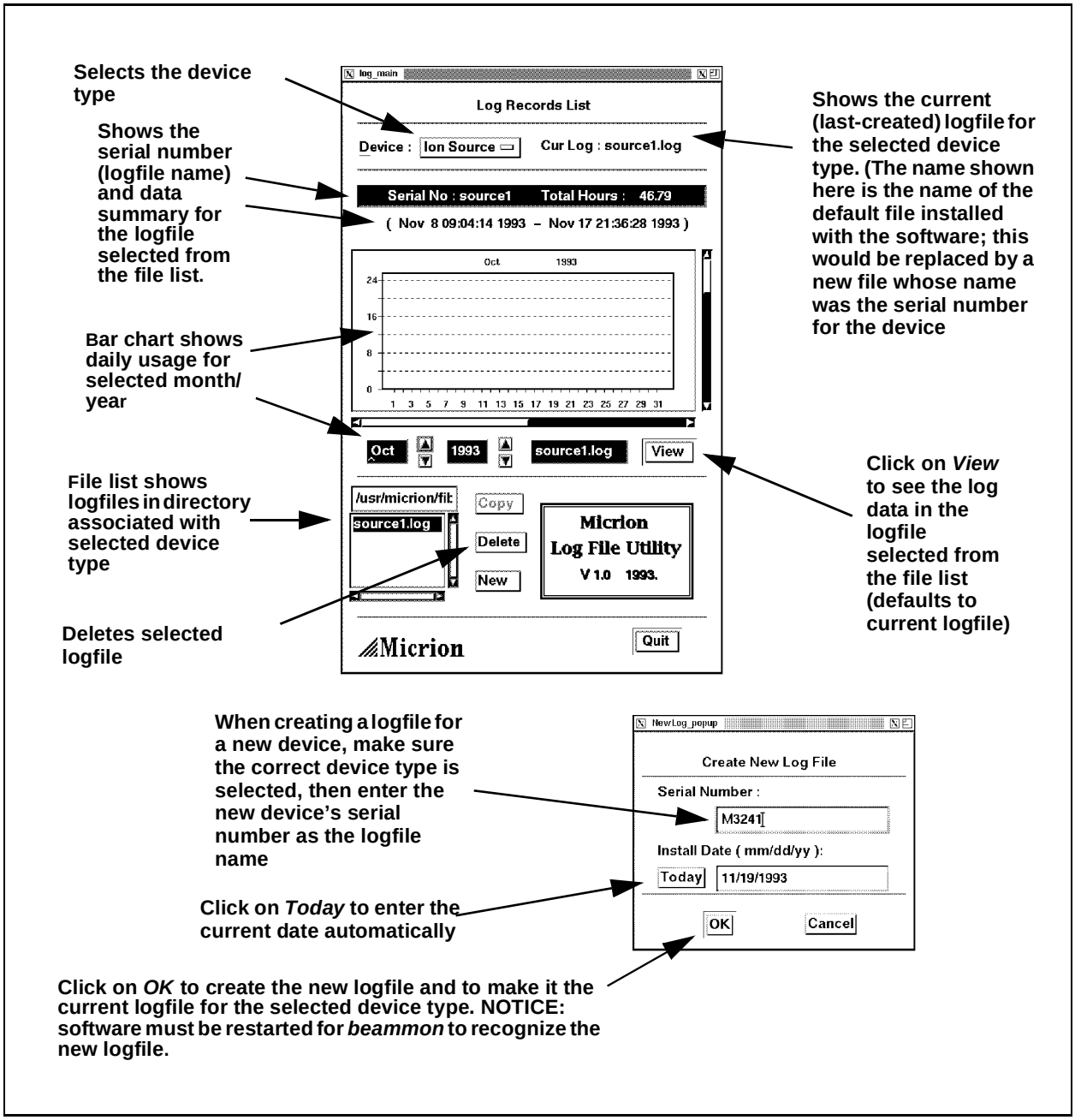

Selects the device type
Shows the serial number (logfile name) and data summary for the logfile selected from the file list.
Bar chart shows daily usage for selected month/ year
File list shows logfiles in directory associated with selected device type
Deletes selected logfile
log_main
Log Records List
Device :
Ion Source
Cur Log : source1.log
Serial No : source1
Total Hours : 46.79
(Nov 8 09:04:14 1993 – Nov 17 21:36:28 1993)
Oct
1993
Oct
1993
source1.log
View
/usr/micrion/fil
source1.log
Copy
Delete
New
Micrion
Log File Utility
V 1.0 1993.
Micrion
Quit
Shows the current (last-created) logfile for the selected device type. (The name shown here is the name of the default file installed with the software; this would be replaced by a new file whose name was the serial number for the device
Click on *View* to see the log data in the logfile selected from the file list (defaults to current logfile)
When creating a logfile for a new device, make sure the correct device type is selected, then enter the new device's serial number as the logfile name
Click on *Today* to enter the current date automatically
Click on *OK* to create the new logfile and to make it the current logfile for the selected device type. NOTICE: software must be restarted for *beammon* to recognize the new logfile.
NewLog_popup
Create New Log File
Serial Number :
M3241
Install Date (mm/dd/yy):
Today
11/19/1993
OK
Cancel

Figure 4. Log File Utility Popups

Part 9. Inspect and Clean the Used Suppressor and Extractor Caps

If the suppressor cap is very dirty, heavily stained, or burn marks are present from arcing, it must be polished. In the case of arcing, clean the extractor cap as well.

Being extremely careful not to drop or scratch it, clean the suppressor cap as follows:

In the Case of Mild Stains

9-1. Wipe away as much of the gallium as possible using clean, dry, cotton tipped swabs. Discard the swabs. Remove all fibers and dust from the cap.

9-2. Wipe the inside of the suppressor cap with a clean cotton tipped swab. Discard the swab.

9-3. Once the cap is clean, prepare to load it with the new, replacement ion source.

In the Case of Burn Marks or Heavy Stains:

9-4. For the **Suppressor Cap**, apply a small amount of the metal polish supplied with the column service kit to a fresh swab. Polish the front and back openings of the aperture in the suppressor cap. Spin the swab stem between your thumb and forefinger. Discard the swab.

9-5. Apply a thin coat of the metal polish to a lint free wiper in an area about 2" by 4".

a. To polish the face of the cap, place the suppressor cap face-down on the polish and move it in a figure-eight pattern while applying light and even pressure.

a. Rotate the cap frequently to ensure uniform polishing.

b. Continue until all stains are removed.

c. Check for deep scratches or dents, which render the cap unusable.

9-6. In a small clean beaker, mix a strong solution of laboratory grade detergent and distilled water.

a. Dip a cotton swab into the solution and wipe the cap inside and out to remove as much of the polishing compound residue as possible. Discard the swab.

b. Gently immerse the cap (not face down) in a beaker half-full of the detergent solution and place the beaker in an ultrasonic cleaner for five minutes.

c. Grasp the cap with tweezers by its mounting rim and carefully remove it from the ultrasonic cleaner.

d. Rinse the cap thoroughly with clean water.

e. Blow it dry with nitrogen or filtered pressurized air.

Do not mar the polished surface or the inside of the aperture.

9-7. In a 100% solution of isopropyl alcohol, gently immerse the cap (not face down) and place the beaker in an ultrasonic cleaner for five minutes.

9-8. For the **Extractor Cap**, to remove and clean it, and re-install it in the extractor cap holder as follows:

9-9. Turn the cap 1/3 turn and pull it past the ball detents in the extractor cap holder.

9-10. The detents are spring-loaded ball-plungers.

9-11. Follow steps 9-5 through 9-7.

9-12. To install the extractor cap, line up the slots with the detents on the extractor cap holder, and push the cap in.

Part 10. Pre-Loading an Ion Source into a Suppressor Cap

10-1. Find the base for the suppressor cap in the replacement kit. Place the suppressor cap in the base. Holding the sleeve of the source tool with the larger opening facing down, place the sleeve over the suppressor cap.

10-2. Break the seals on the source box, and place it upside down on a flat surface. The top section—the smaller of the two sections—should be on the bottom. Carefully lift away the larger section.

10-3. The source is now exposed, needle tip facing up. Remove it with the small tweezers, grasping it by the black disk body. Lift it straight up. DO NOT let the tip come in contact with anything—any contact can permanently damage the source.

10-4. So that the source is held firmly when the cylinder is turned over, adjust the nylon-tipped retaining screws in the cylinder. The pushrod must be able to release the source easily from the cylinder, and the source **must not fall out** when the cylinder is inverted. The source may be damaged if subjected to shock. If necessary, perform this adjustment with the old source.

10-5. Plug the source connector pins into the bottom of the source maintenance tool cylinder, as shown in Figure 5. Seat the source properly in the cylinder by pushing down on the center of the source body with the tip of the tweezers. Be careful of the fragile wire and tip when doing so.

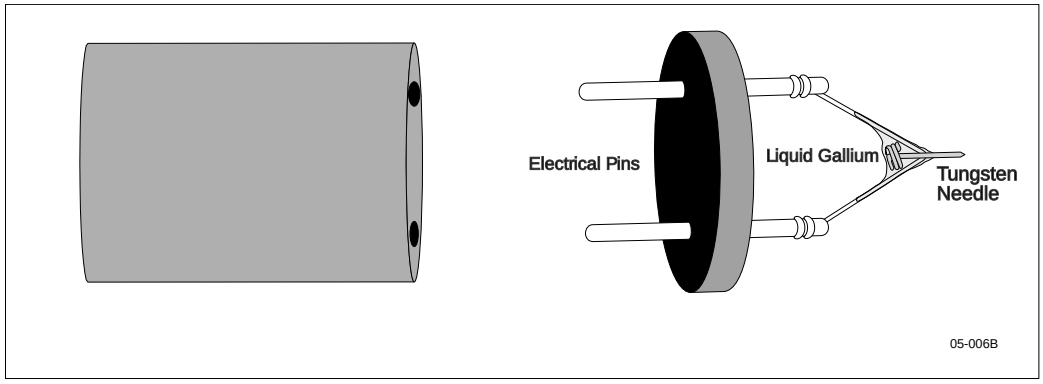


Figure 5. Inserting the Source into the Source Maintenance Cylinder

10-6. Place the cylinder in the sleeve with the source tip pointing downward, as shown in Figure 6. Gently lower the cylinder into the sleeve until the source is resting in the suppressor cap.

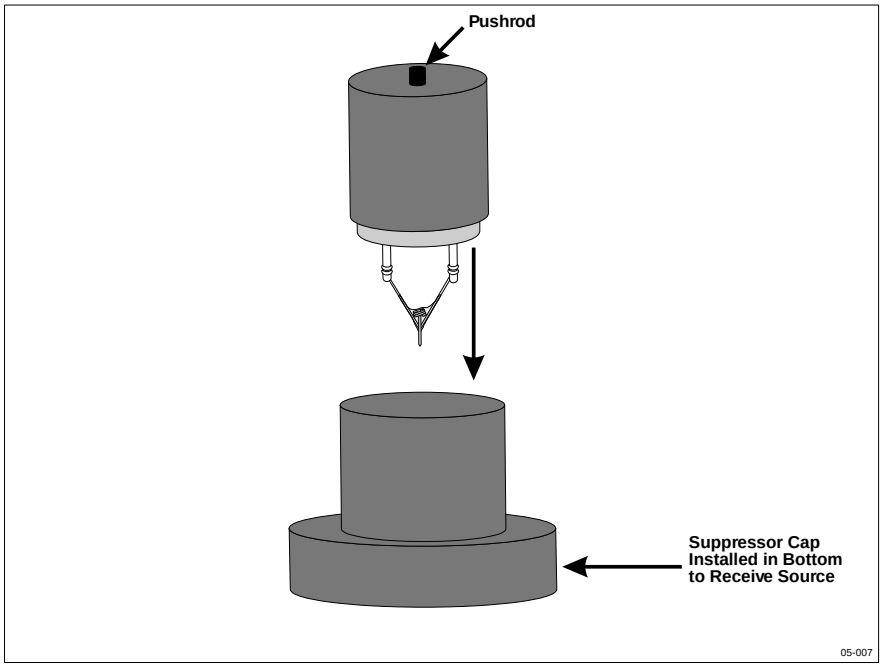


Figure 6. Inserting the Source and Cylinder into the Source Maintenance Sleeve

10-7. Press down on the push rod to gently eject the source part way. Hold down the end of the pushrod while pulling upward on the cylinder in order to unplug the source from the cylinder fully and deposit it in the suppressor cap. Remove the cylinder and sleeve and return them to the column service tool kit.

10-8. Align the source so that the two electrical pins align with the detent reference mark in the suppressor cap, shown in Figure 3. Use the tweezers to rotate the source, being careful to avoid contact with the source pins and needle.

10-9. Align the two source clamps, screwing them in tightly enough to hold the source in place while allowing it to be moved slightly from side to side for alignment. Be sure that the source does not move when the suppressor is tilted on its side, and the source clamps are not near the electrical pins.

10-10. Align the source needle in the center of the hole in the suppressor cap. Move the source from side to side to align it by grasping the electrical pins—**DO NOT ROTATE** the source.

10-11. Place the loaded suppressor into the storage container provided.

Micrion

Service Procedure No.: **05-11**
Service Procedure Title: **Gallium Source Heating**
Applicable Systems: **8000, Micrion 9800 FlipChip**
Frequency of Service: **After curing the column**

Introduction

The source must be heated following installation or system pumpdown, even if the source turns on prior to heating. The column should be cured before the source is heated. This procedure describes the following:

- Determining the hours logged for a source
- Powering down to swap high-voltage Filament cables
- Heating procedure for source

Part 1. Determining the Hours Logged for a Source

Micrion systems run the Log File Utility program in the background to log the hours of operation of the ion source.

To start this utility program, type `log_main` at the prompt in an xterm window.

1-1. In the *Log File* Utility popup, select Ion Source with the *Device* button.

1-2. To see the total hours logged on the source, choose the most recent log file and select View. (This assumes that the source was listed in the log file when it was installed.)

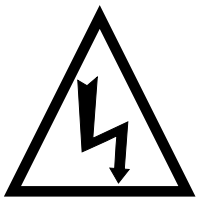
NOTICE

Per paragraph 11.1 of Safety Guidelines for Semiconductor Manufacturing Equipment (S2-93), this procedure is a Type 5 task. Specifically: "Equipment is energized and measurements and adjustments require physical entry into the equipment, or equipment configuration will not allow the use of clamp-on probes."

Part 2. Power Down the System

Before replacing the high-voltage Filament cables, power down the high voltage and turn off the power supply; see Part 1 of Service Procedure 01-02.

WARNING



Dangerously high voltages are present in the process module while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and automatic procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

Part 3. Centering the Source

3-1. To display the Beam Screen, select *Beam Control* on the Tasks menu.

3-2. On the *Beam Control* popup, turn *Beam Maintenance* off and *Upper Scan* off.

3-3. Use the four ion gun housing adjustment knobs (shown in Figure 1) to center the ion gun housing. Use the sight-gap (the gap visible between the ion gun housing and the column) to center the ion gun housing as accurately as possible with your eyes.

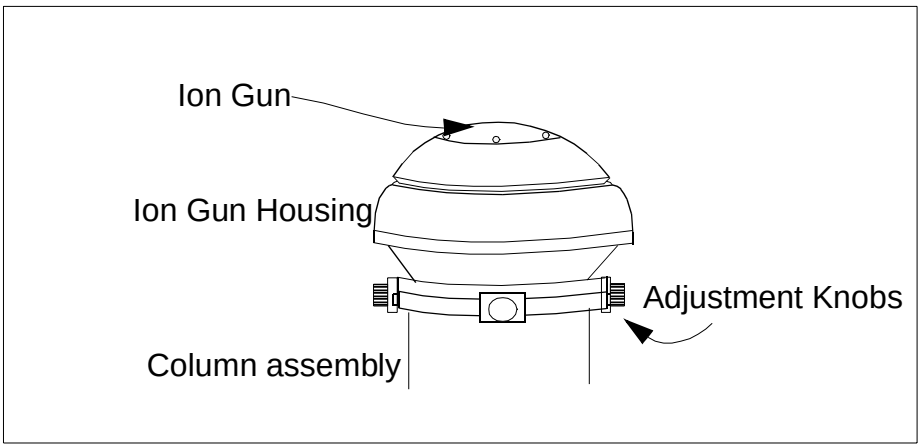


Figure 1. Ion Gun Housing: Side View

NOTE

Use care to maintain emission when adjusting the ion gun position so that the beam does not shut down.

3-4. Click the *Aperture* icon on the *Beam Screen* and select Home on the popup.

3-5. Select a 1350 μm field of view.

3-6. Open the *Suppressor Voltage* popup by clicking on the Suppressor Voltage icon.

3-7. Bring down the Suppressor voltage until the Extractor current is 20 μA.

3-8. Click on the Source Icon.

3-9. Turn on *Upper Scan* and center the image in the window using the adjustment knobs.

3-10. Using the adjustment knobs, adjust the position of the ion gun to minimize the extraction current reading in one axis; repeat for the other axis, and go back and forth adjusting the two axes. When the extraction current is at its minimum reading, the source is roughly centered over the extractor aperture.

Part 4. Heating the Source

If you are heating a 10 nm or a 25 nm column, there is no need to replace the Filament cables, since the change to low-resistance is done through the relay box in these systems.

4-1. Switch off the high voltages as described in Service Procedure 01-02.

4-2. To heat the source, replace the resistive cables (160-6444) with low-resistance Filament cables (160-6445). After heating, replace the low-resistance cables with the resistive Filament cables, being sure.

NOTICE

Each time cables are removed from the high-voltage connectors, the ends must be cleaned with a cloth dampened with isopropyl; all metal particles and other contaminants must be eliminated. Allow the cable ends to dry before reinserting.

4-3. Once the cables are swapped, power up as described in Service Procedure 01-01.

4-4. In Microsurgery, select *Beam Control* from the Tasks pulldown menu. Bring up the *Beam Control* popup by clicking the left botton with the mouse cursor within the image area.

4-5. On the *Beam Control* popup, select Tasks and click *Beam Maintenance* off.

4-6. On the *Beam Screen*, set Accel voltage to 0 kV.

4-7. On the *Beam Control* popup, set Suppression voltage to 0 kV.

4-8. On the *Beam Control* popup, increase the Extractor voltage until the Extractor current is between 2 μA and 5 μA. The Extractor voltage should not exceed 8 kV. If there is no Extractor current, keep the Extractor voltage at 8 kV and go to the next step.

4-9. On the *Ion Source* popup, quickly bring the Filament current to 4900 μA.

Note: Extractor current typically rises slowly to between 50 μA and 80 μA, and then increases rapidly to its maximum.

4-10. When the Extractor current increases rapidly to between 100 μA and 300 μA *without* exceeding the time shown in Table 1, immediately reduce the Filament current to 0.

Note: If the Extractor current does not reach 125 µA before the allowed time has expired, reduce the Filament current and verify the Filament readback. If the readbacks are working, call Micrion Product Support.

4-11. On the *Beam Control* popup, bring the Extractor voltage down until the Extractor current is about 10 µA. Allow the source to emit for about five minutes.

Table 1: Source Heating: Time per Hours Used

Hours Logged on Source	Heating Time
0 - 499	19 seconds
500 - 649	15 - 18 seconds
650 - 879	12 seconds
880 - 999	10 - 12 seconds
1000 +	10 - 12 seconds

4-12. Finally, power down as described in Part 2, and replace the low-resistance cables (160-6445) with the resistive cables (160-6444).

NOTICE

Each time cables are removed from the high-voltage connectors, the ends must be cleaned with a cloth dampened with isopropyl; all metal particles and other contaminants must be eliminated. Allow the cable ends to dry before reinserting.

Micrion

Service Procedure No.: **05-12-05**
Service Procedure Title: **Column and Lens Curing: 5 nm Column**
Applicable Systems: **8000, Micrion 9800 FlipChip, MicroMill HT**
Frequency of Service: **After Pumpdown (following venting) or HV Shutdown**

Introduction

The curing procedure conditions the column for high-voltage operation. The procedure consists of three parts: preparation, curing the column, and curing the lenses.

Depending upon the condition of the column, it may be necessary to repeat the entire curing process several times to obtain satisfactory results. Table 1 shows the conditions for curing and the estimated curing times.

Notice

If the column is not properly cured, there is a risk of irreversible damage during operation.

The general curing technique is to increase the electrical potentials on the various column elec-

Table 1: Conditions for Curing and Cure Time

Column Condition	Est. Time
Column has been newly installed	2 hrs
Chamber has been vented	2 hrs
High voltage has been off for 12 hours or more (in which case this procedure need be done only once)	1/2 hr

trodes slowly, so as to induce relatively minor high-voltage breakdowns (sparks) in a manner in which they can be controlled. Thus, you increase a potential gradually until sparking just begins to occur, whereupon you briefly stop and wait for the sparking to subside. If the sparking does not subside quickly, you must “back off ” the potential and try again.

The three indicators of *sparking* are:

- Very short duration snowy or white streaksin the SIM image (with the imaging conditions set up as described in Part 1),
- Short to medium duration snowy or white streaks or banding on a mostly snowy background; success depends upon technique and skill
- Total background snow with occasional streaks that is linear with lens voltage; usually there is little reaction (as sharp pressure bursts) from the ion pump current in this mode; if this condition exists, STOP IMMEDIATELY and consult a column guru, i.e., one who is certified by the Micrion Optics Dept.

Pressure bursts (momentary rises in gas pressure), which result in corresponding bursts of ion pump current, may accompany the sparking. These pressure bursts determine the status. When the column pressure is normal (between 1.0 and 2.0 x 10^{-6} torr), the pump current scale (the LED stack) on the front panel of the Varian MiniVac controller for the ion pump shows no appreciable pump current (no LED lighted). A pressure burst may result in a pump current burst of several milliamperes. If the current fails to return to 10^{-6} torr after five seconds, or if it appears to be increasing, you must quickly restore the potential that you are manipulating to a level that allows the pressure to recover. To detect pressure bursts with greater sensitivity and shorter response time than are provided by the LEDs on the MiniVac controller panel, connect a multimeter to the BNC connector (labelled *1V = 1mA*) on the MiniVac controller panel. Normal high vacuum would register as something in the range of 100 to 150 millivolts.

Curing is normally done by increasing the potential applied to an electrode. In the remainder of this procedure, the statement *monitor the column behavior* means: watch the image for signs of sparking in the column and watch the ion pump current indicator.

In all cases. curing should be done as described in step 3-4.

Part 1. Preparation

1-1. Make sure that both the system pressure and the column pressure are less than 1.5 x 10^{-6} torr and that the pumps and valves are in the proper states.

1-2. To detect pressure bursts with greater sensitivity and shorter response time than are provided by the LEDs on the MiniVac controller panel, connect a multimeter to the BNC connector (labelled *1V = 1mA*) on the MiniVac controller panel. Normal high vacuum is in the range of 100 to 150 millivolts.

1-3. Make sure that the normal (resistive) cables (p/n 160-6444), are connecting the filament to its power supply (F^- and F^+ on the rear of the high voltage power supply).

1-4. Display the Beam Screen (select *Beam Control* on the Tasks menu).

1-5. On the Beam Screen, click on the image area with the left mouse button to display the Beam Control popup. Throughout this procedure, you will use the sliders in the Beam Control popup to control most of the column voltages.

1-6. In an xterm window, type:

```
hvshell
```

1-7. In the hvshell, type the command that enables high voltage:

```
hvenbl 1
```

Allow the hvshell to continue running in the background.

NOTICE

Do not use the Ion Source popup to enable high voltage, because this automatically places Lens 1 and Lens 2 at a voltage level that is potentially damaging to the column.

1-8. On the Beam Screen (lower right), select electron imaging mode, select the 256 pixel image size, and start continuous imaging at the *fast* rate.

1-9. Turn the Brightness knob on the control panel until the image changes from gray to black.

1-10. On the Beam Screen, click on the MCP graphic to display the MCP Control popup. With the Bias slider set at 400, set the Gain slider as follows:

a. Slowly bring the Gain to 500 V, and wait 5 seconds.

b. Slowly bring the Gain to 1000 V, and wait 5 seconds.

c. Slowly bring the Gain to 1350 V.

d. With no voltages applied to the column, adjust the Gain to display sparse white speckles (single electrons) on the screen. (It may be helpful to darken the room.)

1-11. Close the MCP Control popup.

Part 2. Curing Lens 1

This part of the procedure is to be used on systems in which the column is operated with a negative potential on Lens 1 (the Lens 1 Voltage slider shows –15 kV to –20 kV possible). The Accelerator voltage should be at 0 volts at this time.

2-1. While monitoring the column behavior, slowly increase the lens 1 voltage until you observe noise; then proceed based on the type of noise as described in the Introduction under three indicators of sparking.

2-2. Slowly bring the lens 1 voltage back down to 0 V and wait until the voltage readback catches up.

2-3. In the *Ion Source* popup, set the Accelerator voltage to 0 V.

2-4. Set the Accelerator voltage to 5 kV. Monitor the column behavior.

2-5. Set the Accelerator voltage to 10 kV. Monitor the column behavior.

2-6. Using the Extractor Voltage slider, slowly increase the Extractor voltage to 5000 V while monitoring the column behavior.

2-7. Increase the Accelerator voltage by 5 kV. Monitor the column behavior.

2-8. While monitoring the column behavior, slowly bring the Extractor voltage down to 0 V, and then bring it back up to 5000 V. (Sparking is likely to occur as you bring the Extractor voltage down toward 0 volts.)

2-9. Repeat steps 2-7 and 2-8 (in 5kV increments) until you have done so with the Accelerator voltage at 40 kV, then continue with the next step.

2-10. Increase the Accelerator voltage from 40 kV to 45 kV, then immediately reduce it to 40 kV.

2-11. While monitoring the column behavior, slowly bring the Extractor voltage to 0 V and back to up 5 kV.

2-12. Increase the Accelerator voltage to 45 kV. Monitor the column behavior.

2-13. While monitoring the column behavior, slowly bring the Extractor voltage down to 0 V and back up to 5 kV.

2-14. Increase the Accelerator voltage to 50 kV, then immediately lower it to 40 kV.

2-15. Leave the Accelerator voltage at 40 kV. While monitoring the column behavior, slowly bring the Extractor voltage down to 0 V and back to 5 kV.

2-16. Increase the Accelerator voltage to 45 kV. While monitoring the column behavior, slowly bring the Extractor voltage down to 0 V and back to 5 kV.

2-17. Increase the Accelerator voltage to 50 kV. Monitor the column behavior.

2-18. While monitoring the column behavior, bring the Extractor voltage to 0 V.

2-19. Slowly increase the *Suppressor* voltage to 2 kV while monitoring the column behavior. Maintain for five minutes.

2-20. Increase the lens 1 voltage from 0 V to –20 kV while monitoring the Extractor voltage readback. The Extractor voltage should be less than 200V. If the Extractor voltage is greater than 200V. clean the column as described in Service Procedure 05-02.

2-21. Slowly bring the Suppressor voltage down to 0 V.

2-22. Slowly step the Accelerator voltage down from 50 kV to 0 V in 5 kV steps.

2-23. In the hvshell, type the command that disables high voltage:

```
hvenbl 0
```

2-24. While monitoring the column behavior, slowly increase the lens 2 voltage until you observe noise; then proceed based on the type of noise as described in the Introduction under three indicators of sparking.

2-25. Slowly bring the lens 1 voltage back down to 0 V. If sparking occurs at about 3 kV, wait for 10 seconds and then continue.

Part 3. Curing Lens 2

3-1. Click on the Lens 2 schematic symbol in the Beam Control popup screen to display the slider voltage control for Lens 2.

3-2. Set L2 to 0 V, then enable the L2 power Supply.

3-3. Using the slider control, gradually raise the L2 voltage towards 35 kV.

3-4. At the first sign of noise[1] or pressure bursts in the ion pump (usually 25 kV to 30 kV):

a. Increase L2 voltage by 3 kV above the point where the noise began.

b. Quickly decrease L2 by at least 2 kV; the noise should stop. It is important that the noise does not continue when you decrease the voltage level—decrease the voltage until the noise stops.

Repeat this step until you can set L2 to 30 kV without producing noise. Once you have done so, the procedure is complete. Figure 1 is a graphical representation of this step. If you cannot increase L2 to 30 kV without producing noise, proceed to step 3-5.

---

[1] The "noise" referred to is the arcing (white flashes) visible in the imaging screen while under continuous imaging. The three indicators of *sparking* are:

Very short duration snowy or white streaks in the SIM image (with the imaging conditions set up as described in Part 1),

Short to medium duration snowy or white streaks or banding on a mostly snowy background; success depends upon technique and skill

Total background snow with occasional streaks that is linear with lens voltage; usually there is little reaction (as sharp pressure bursts) from the ion pump current in this mode; if this condition exists, STOP IMMEDIATELY and consult a column guru, i.e., one who is certified by the Micrion Optics Dept.

3-5. Increase L2 voltage to 5 kV above the level where noise begins.

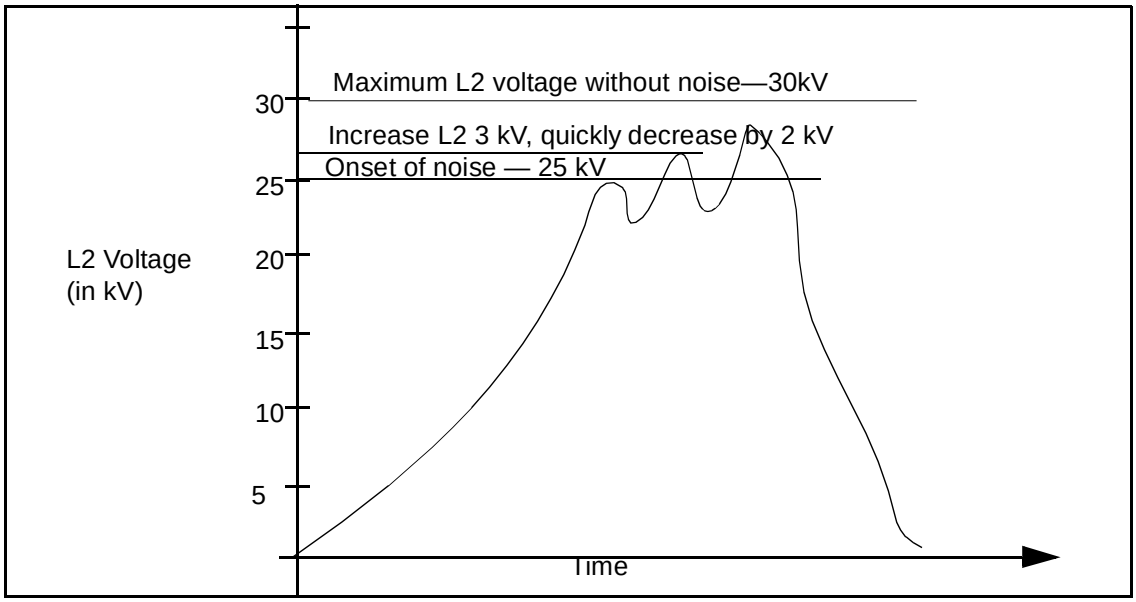


Figure 1. L2 Curing Procedure I

a. Immediately lower L2 to 0 V and wait for the noise to stop (The noise may stop and the pressure may drop before 0 V, but bring it to 0 V just the same).

b. Increase L2 voltage again and record the voltage before the onset of noise. Repeat this step once or twice to reach an L2 voltage of 30 kV without noise. Once you have done so, the procedure is complete.

If you cannot increase L2 voltage to 30 kV without incurring noise, proceed to step 3-6, which is illustrated in Figure 2.

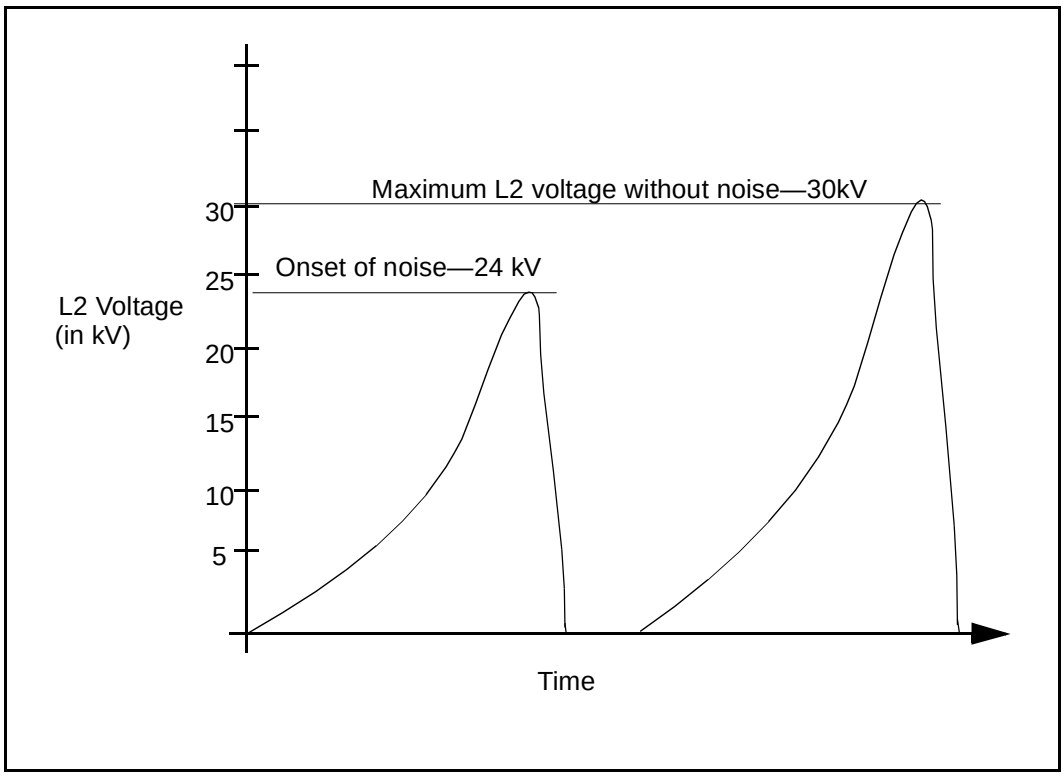


Figure 2. L2 Curing Procedure II

3-6. If step 3-5 does not eliminate noise below 30 kV, proceed as follows:

a. Locate the focus power supply in the electronic module rack. Turn it off.

b. Set the L2 control to 30 kV.

c. Turn on the focus power supply for 2 seconds and turn it off.

d. Reduce the L2 control to 0 V and turn on the focus power supply.

e. Increase L2 and observe any gain in L2 voltage before noise is produced.

f. If necessary, perform steps 3-3 and 3-5 again. If there is still no gain in L2 voltage before noise is produced, repeat this step with L2 set to 30 kV.

g. The procedure is complete. If you are unable to bring L2 to 50 kV without noise after following this procedure, please call the Micrion Optics Dept.

If you are unable to cure the column without great difficulty, please call the Micrion Optics Dept.

Micrion

Service Procedure No.: **05-12-10**
Service Procedure Title: **Column and Lens Curing: 10 nm Column**
Applicable Systems: **8000, Micrion 9800 FlipChip, MicroMill HT**
Frequency of Service: **After Pumpdown (following venting) or HV Shutdown**

Introduction

This procedure describes how to cure the lower lens (L2) in the Micrion 10 nm ion beam column. "Curing" refers to the process of conditioning the lens by slowly increasing L2 voltage.

Use this procedure after the workchamber has been vented, when installing a new column, or after you have performed preventive maintenance or repairs on an existing column. You can eliminate particulate contamination by following Service Procedure 05-02-10, Cleaning the Lower Column (Lens 2) Elements: 10 nm Column.

Required Materials

This procedure requires the following materials:

- Standard field service toolkit
- Voltmeter

NOTICE

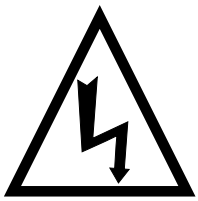
If L2 is not cured properly, there is risk of severe damage to the column.

Part 1. Preparation

1-1. Make sure that the system pressure is less than 1.5×10^{-6} torr and that the pumps and valves are in the proper states.

1-2. To detect pressure bursts with greater sensitivity and shorter response time than are provided by the LEDs on the MiniVac controller panel, connect a multimeter to the BNC connector (labelled *1V = 1mA*) on the MiniVac controller panel. Normal high vacuum is in the range of 100 to 150 millivolts.

WARNING



Dangerously high voltages are present in the process module, the electronics module, and the column while the FIB system is powered up. Make sure that all high voltage is disabled before changing the cables connecting the filament to its power supply. Do *not* rely only on the software Power Down function. Disable the voltages using both manual and automatic procedures.

1-3. Make sure that the low-resistive cables (p/n 160-6444), rather than the normal (resistive) cables, are connecting the filament to its power supply (F^- and F^+ on the rear of the high voltage power supply).

1-4. Display the Beam Screen (select *Beam Control* on the Tasks menu).

1-5. On the Beam Screen, click on the image area with the left mouse button to display the Beam Control popup. Throughout this procedure, you will use the sliders in the Beam Control popup to control most of the column voltages.

1-6. In an xterm window, type:

```
hvshell
```

1-7. In the hvshell, type the command that enables high voltage:

```
hvenbl 1
```

Allow the hvshell to continue running in the background.

NOTICE

Do not use the Ion Source popup to enable high voltage, because this automatically places Lens 1 and Lens 2 at a voltage level that is potentially damaging to the column. On the Beam Screen (lower right), select electron imaging mode, select the 256 pixel image size, and start continuous imaging at the *fast* rate.

1-8. Turn the Brightness knob on the control panel until the image changes from gray to black.

1-9. On the Beam Screen, click on the MCP graphic to display the MCP Control popup. With the Bias slider set at 400, set the Gain slider as follows:

a. Slowly bring the Gain to 500 V, and wait 5 seconds.
b. Slowly bring the Gain to 1000 V, and wait 5 seconds.
c. Slowly bring the Gain to 1350 V.
d. Adjust the Gain to display sparse white speckles (single electrons) on the screen (It may be helpful to darken the room). You want to display the white speckles on the screen under continuous imaging with L2 set at 0 V.

1-10. Close the MCP Control popup.

Part 2. Curing the Column

2-1. Click on the Lens 2 schematic symbol in the Beam Control popup screen to display the slider voltage control for Lens 2.

2-2. Set L2 to 0 V, then enable the L2 power supply.

2-3. Using the slider control, gradually raise the L2 voltage towards 30 kV.

2-4. At the first sign of noise[1] or pressure bursts in the ion pump (usually 25 kV to 30 kV):

a. Increase L2 voltage by 3 kV above the point where the noise began.

b. Quickly decrease L2 by at least 2 kV; the noise should stop. It is important that the noise does not continue when you decrease the voltage level—decrease the voltage until the noise stops.

Repeat this step until you can set L2 to 30 kV without producing noise. Once you have done so, the procedure is complete. Figure 1 is a graphical representation of this step. If you cannot increase L2 to 30 kV without producing noise, proceed to step 2-5.

---

[1] The "noise" referred to is the arcing (white flashes) visible in the imaging screen while under continuous imaging. The three indicators of *sparking* are:

Very short duration snowy or white streaks in the SIM image (with the imaging conditions set up as described in Part 1),

Short to medium duration snowy or white streaks or banding on a mostly snowy background; success depends upon technique and skill

Total background snow with occasional streaks that is linear with lens voltage; usually there is little reaction (as sharp pressure bursts) from the ion pump current in this mode; if this condition exists, STOP IMMEDIATELY and consult a column guru, i.e., one who is certified by the Micrion Optics Dept.

2-5. Increase L2 voltage to 5 kV above the level where noise begins.

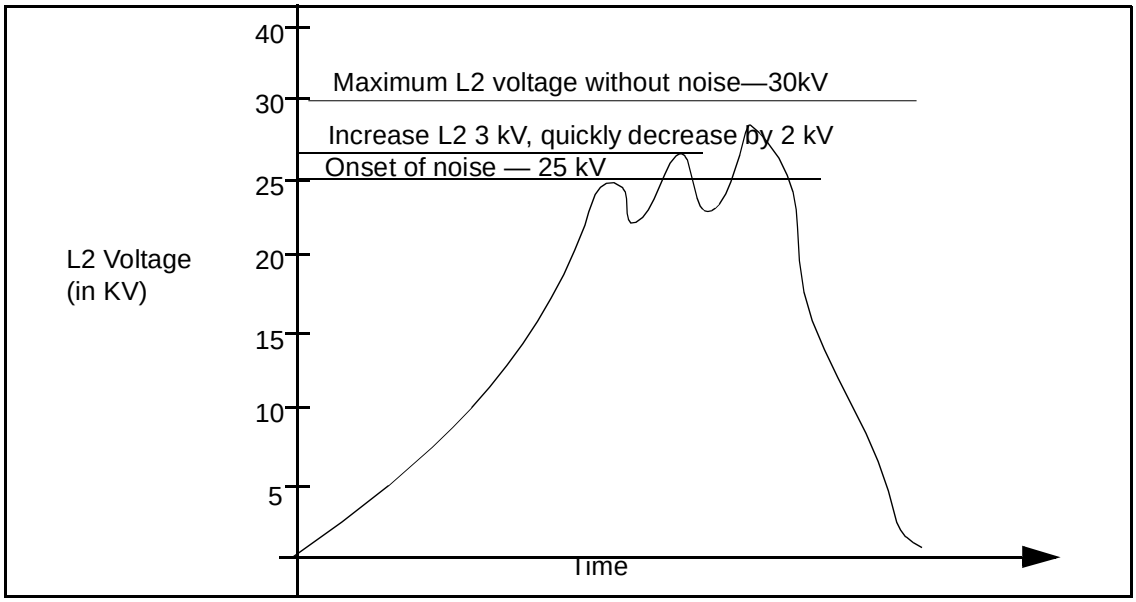


Figure 1. L2 Curing Procedure I

a. Immediately lower L2 to 0 V and wait for the noise to stop (The noise may stop and the pressure may drop before 0 V, but bring it to 0 V just the same).

b. Increase L2 voltage again and record the voltage before the onset of noise. Repeat this step once or twice to reach an L2 voltage of 30 kV without noise. Once you have done so, the procedure is complete.

If you cannot increase L2 voltage to 30 kV without incurring noise, proceed to step 2-6, which is illustrated in Figure 2.

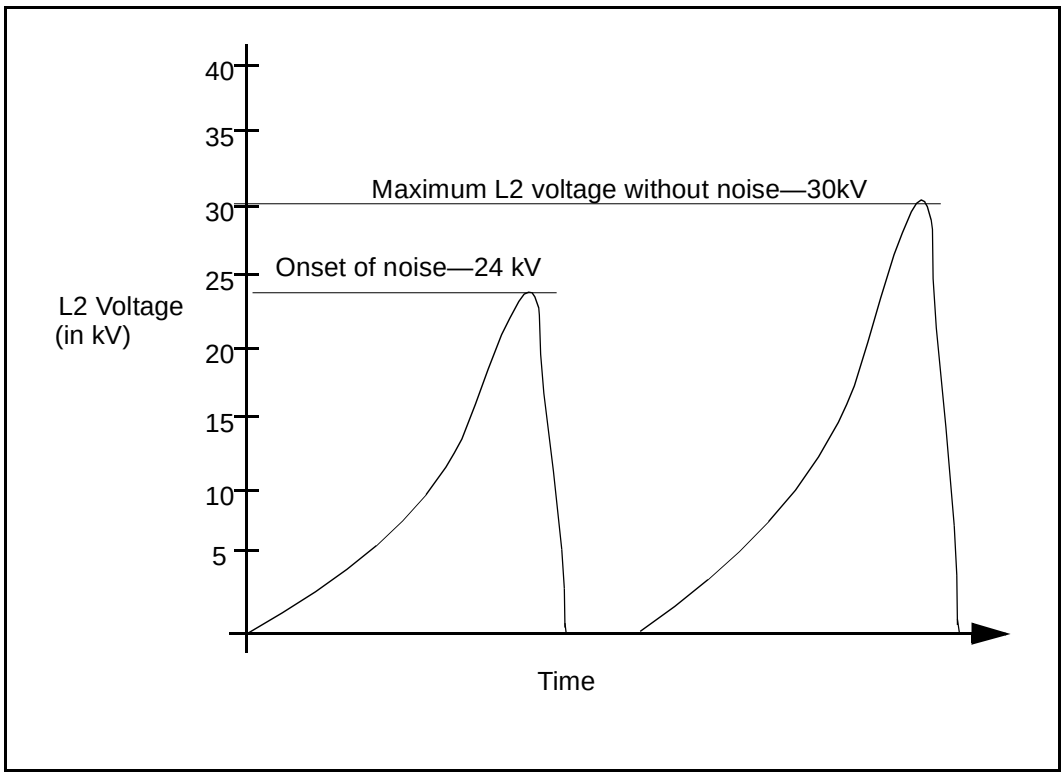


Figure 2. L2 Curing Procedure II

2-6. If step 2-5 does not eliminate noise below 30 kV, proceed as follows:

a. Locate the focus power supply in the electronic module rack. Turn it off.

b. Set the L2 control to 30 kV.

c. Turn on the focus power supply for 2 seconds and turn it off.

d. Reduce the L2 control to 0 V and turn on the focus power supply.

e. Increase L2 and observe any gain in L2 voltage before noise is produced.

f. If necessary, perform steps 2-3 and 2-5 again. If there is still no gain in L2 voltage before noise is produced, repeat this step with L2 set to 30 kV.

g. The procedure is complete. If you are unable to bring L2 to 30 kV without noise after following this procedure, please call the Micrion Optics Dept.

Micrion

Service Procedure No.: **05-12-25**
Service Procedure Title: **Column and Lens Curing: 25 nm Column**
Applicable Systems: **8000, Micrion 9800 FlipChip, MicroMill HT**
Frequency of Service: **After Pumpdown (following venting) or HV Shutdown**

Introduction

This procedure describes how to cure the second lens (L2) in the Micrion 25 nm ion beam column. “Curing” refers to the process of conditioning the lens by slowly increasing L2 voltage.

Use this procedure after the workchamber has been vented, when installing a new column, or after you have performed preventive maintenance or repairs on an existing column. You can eliminate particulate contamination by following Service Procedure 05-02-25, Cleaning the Lower Column (Lens2) Elements: 25 nm Column.

Required Materials

This procedure requires the following materials:

- Standard field service toolkit
- Voltmeter

NOTICE

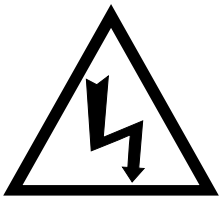
If L2 is not cured properly, there is risk of severe damage to the column.

Part 1. Preparation

1-1. Make sure that the system pressure is less than 1.5×10^{-6} torr and that the pumps and valves are in the proper states.

1-2. To detect pressure bursts with greater sensitivity and shorter response time than are provided by the LEDs on the MiniVac controller panel, connect a multimeter to the BNC connector (labelled *1V = 1mA*) on the MiniVac controller panel. Normal high vacuum is in the range of 100 to 150 millivolts.

WARNING



Dangerously high voltages are present in the process module, the electronics module, and the column while the FIB system is powered up. Make sure that all high voltage is disabled before changing the cables connecting the filament to its power supply. Do *not* rely only on the software Power Down function. Disable the voltages using both manual and automatic procedures.

1-3. Make sure that the low-resistive cables (p/n 160-6444), rather than the normal (resistive) cables, are connecting the filament to its power supply (F^- and F^+ on the rear of the high voltage power supply).

1-4. Display the Beam Screen (select *Beam Control* on the Tasks menu).

1-5. On the Beam Screen, click on the image area with the left mouse button to display the Beam Control popup. Throughout this procedure, you will use the sliders in the Beam Control popup to control most of the column voltages.

1-6. In an xterm window, type:

```
hvshell
```

1-7. In the hvshell, type the command that enables high voltage:

```
hvenbl 1
```

Allow the hvshell to continue running in the background.

NOTICE

Do not use the Ion Source popup to enable high voltage, because this automatically places Lens 1 and Lens 2 at a voltage level that is potentially damaging to the column.On the Beam Screen (lower right), select electron imaging mode, select the 256 pixel image size, and start continuous imaging at the *fast* rate.

1-8. Turn the Brightness knob on the control panel until the image changes from gray to black.

1-9. On the Beam Screen, click on the MCP graphic to display the MCP Control popup. With the Bias slider set at 400, set the Gain slider as follows:

a. Slowly bring the Gain to 500 V, and wait 5 seconds.
b. Slowly bring the Gain to 1000 V, and wait 5 seconds.
c. Slowly bring the Gain to 1350 V.
d. With no voltages applied to the column, adjust the Gain to display sparse white speckles (single electrons) on the screen. (It may be helpful to darken the room.)

1-10. Close the MCP Control popup.

Part 2. Procedure

2-1. Click on the Lens 2 schematic symbol in the Beam Control popup screen with the left mouse button to display the slider voltage control for Lens 2.

2-2. Set L2 to 0 V, then enable the L2 power supply.

2-3. Using the slider control, gradually raise the L2 voltage towards 30 kV.

2-4. At the first sign of noise[1] or pressure bursts in the ion pump before 25 kV, remove the column and clean it.

2-5. At the first sign of noise or pressure bursts in the ion pump after 25 kV:

a. Increase L2 voltage by 3 kV above the point where the noise began.

b. Quickly decrease L2 by at least 2 kV; the noise should stop. It is important that the noise does not continue when you decrease the voltage level—decrease the voltage until the noise stops.

Repeat this step until you can set L2 to 40-42 kV without producing noise. Once you have done so, the procedure is complete. If you cannot increase L2 to 40-42 kV without producing noise, proceed to step 2-6.

2-6. Increase L2 voltage to 5 kV above the level where noise begins.

a. Immediately lower L2 to 0 V and wait for the noise to stop. (The noise may stop and the pressure may drop before 0 V, but bring it to 0 V just the same.)

b. Increase L2 voltage again and record the voltage before the onset of noise. Repeat this step once or twice to reach an L2 voltage of 40-42 kV without significant noise. Once you have done so, the procedure is complete.

If you cannot increase L2 voltage to 40-42 kV without incurring noise, proceed to step 2-7.

2-7. If step 2-6 does not eliminate noise below 30 kV, proceed as follows:

a. Locate the focus power supply in the electronic module rack. Turn it off.

b. Set the L2 control to 45 kV.

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[1] The “noise” referred to is the arcing (white flashes) visible in the imaging screen while under continuous imaging. The three indicators of *sparking* are:

Very short duration snowy or white streaks in the SIM image (with the imaging conditions set up as described in Part 1),

Short to medium duration snowy or white streaks or banding on a mostly snowy background; success depends upon technique and skill

Total background snow with occasional streaks that is linear with lens voltage; usually there is little reaction (as sharp pressure bursts) from the ion pump current in this mode; if this condition exists, STOP IMMEDIATELY and consult a column guru, i.e., one who is certified by the Micrion Optics Dept.

c. Turn on the focus power supply for 2 seconds and turn it off.

d. Reduce the L2 control to 0 V and turn on the focus power supply.

e. Increase L2 and observe any gain in L2 voltage before noise is produced.

f. If necessary, perform steps 2-3 and 2-6 again.

2-8. If there is still no gain in L2 voltage before noise is produced, finally with great caution, repeat this step with L2 set to 30 kV.

The procedure is complete. If you are unable to bring L2 to 40-42 kV without noise after following this procedure, please call the Micrion Optics Dept.

Micrion

Service Procedure No.: **05-13**
Service Procedure Title: **Column Alignment**
Applicable Systems: **8000, Micrion 9800 FlipChip, MicroMill HT**
Frequency of Service: **After installing new source, apertures, or column**

Introduction

This procedure describes how to align the ion beam column after performing maintenance procedures such as installing a new source, changing the aperture(s), or installing a new column.

This procedure includes two parts:

1. Source alignment
2. Aperture alignment

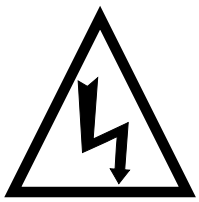
The approach is iterative and gradual: first move the source a little, then move the aperture a little, gradually eliminating wobble until the wobble is gone.

Prerequisites

This procedure assumes that you have properly installed the column, the system is under vacuum, and that you have conditioned the column if necessary.

The following Service Procedures are completed before alignment: Column and Lens Curing, and Source Heating.

WARNING



While the FIB system is powered up, dangerously high voltages are present in the process module, the electronics module, the column, and the high voltage cables connected to the the ion gun and the column. **Do not touch the column and ion gun high voltage cables or connectors unless you are certain that all high voltage is disabled.** Do *not* rely only on the software Power Down function. Disable the high voltages using both manual and automatic procedures.

Part 1. Aligning the Source

1-1. To display the Beam Screen, select *Beam Control* on the Tasks menu.

1-2. On the *Beam Control* popup, turn *Beam Maintenance* off and *Upper Scan* off.

1-3. Use the four knurled, ion gun housing adjustment knobs shown in Fig. 1 to center the ion gun housing by eye.

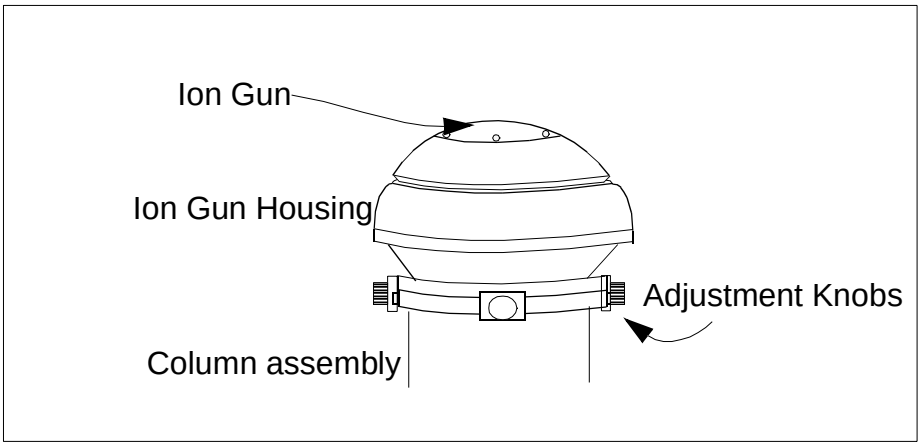


Figure 1. Ion Gun Housing: Side View

NOTE

Use care when adjusting the ion gun position so that the beam does not shut down.

1-4. Click the *Aperture* icon on the *Beam Screen*. and select Home on the popup (see Fig. 2).

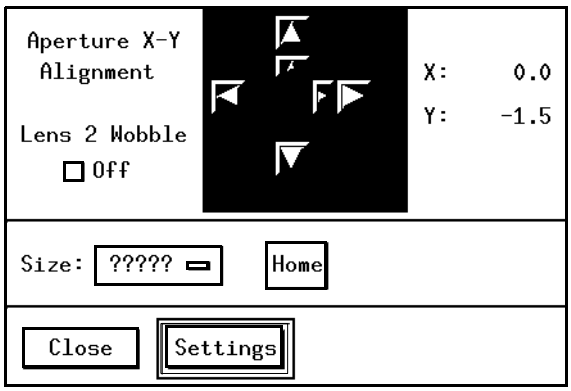


Figure 2. Aperture Control Popup

1-5. Select a 1350 µm field of view.

1-6. Call the *Suppressor Voltage* popup by clicking on the Suppressor Voltage icon.

1-7. Bring down the Supressor voltage until the Extractor current is 20 µA.

1-8. Using the adjustment knobs, adjust the position of the ion gun to minimize the extraction current reading in one axis; repeat for the other axis, and go back and forth adjusting the two axes.

When the extraction current is at its minimum reading, the source is centered over the extractor aperture as much as possible (see Fig. 3).

1-9. Click on the Source Icon.

1-10. Turn on *Upper Scan* and center the image in the window using the adjustment knobs.

1-11. Once you have centered the source, reduce the extraction current to approximately 5µA using the appropriate voltage controls for the suppressor and extractor in the *Beam Control* popup. If the source is new, run it at approximately 5 µA for 30 to 60 minutes.

Figure 3 is a block diagram of the column filament, extractor, and suppressor currents.

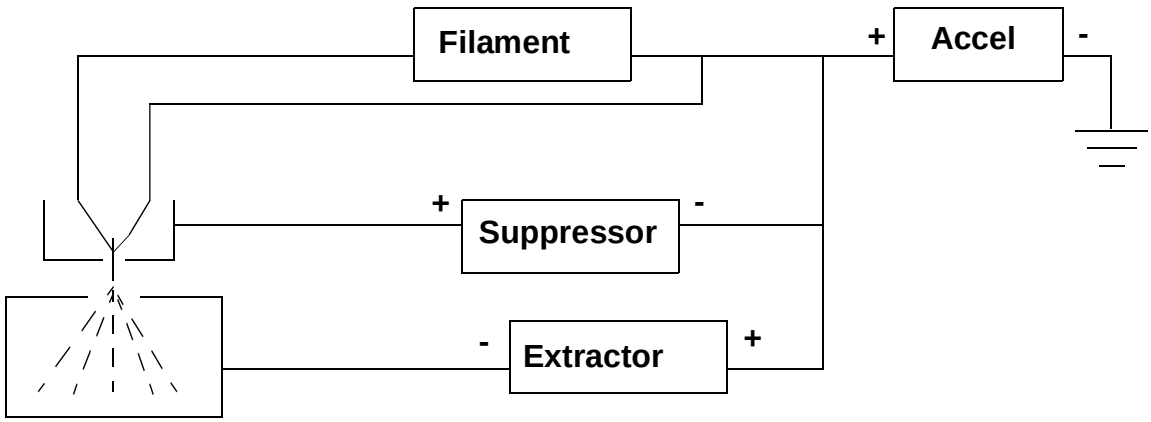


Figure 3. Block Diagram: Suppressor, Extractor, and Filament Current

With the apertures homed, align the source through L1 as follows:

1-12. Set the Field of View to 400 µm using the arrows in the Microsurgery program, or using the Magnification knob on the knob panel to decrease the field of view.

1-13. Move the stage to a focusing target such as the ion faraday grid.

1-14. Focus Lens 2 using the Focus knob or the L2 slider.

1-15. Set the imaging resolution to 256 in the *Imaging Control Box* in the Beam Control main screen, resolve the field of view to 50 μm, and observe a single grid intersection.

1-16. In the Aperture Control popup, select the smallest aperture, note the L1 voltage, then reselect Home. Set L1 to the noted voltage.

1-17. Click on the ion source schematic symbol to display the Ion Source Popup.

1-18. Turn on *L1 Wobble*[1]. Look for up/down or side-to-side movement of the grid intersection. (For 10 nm and 25 nm columns, the wobble function varies L1 voltage by +/- 500V.)

NOTE: The wobble function causes the image to go in and out of focus, however, any side to side or up and down motion indicates that the beam is not passing through the center of L1.

Part 2. Aligning the First Aperture

The alignment process is iterative between the gun and the small aperture until the wobble is eliminated from L1 and L2. Never align in single adjustments of each, or a divergent alignment will result.

For each aperture, L1 should be adjusted for correct beam current; L2 should be adjusted for focus. The lens tables will save L1, L2, and stig settings automatically for each aperture. (See Figure 4 for the *Settings* popup.)

2-1. In the Aperture Control popup (Figure 4), select one of the smaller diameter apertures, i.e. 25 μm or 50 μm.

Make sure that the beam is passing through the aperture, as evidenced by an image of the ion faraday or by the ion faraday current reading.

2-2. Adjust the focus to a 30 μm field of view or smaller.

2-3. Zero the stigmations.

2-4. Focus the image with Lens 2 and stigmate the beam.

2-5. Turn on the *Lens 2 Wobble* function. (For 10 nm and 25 nm columns, this function varies the L2 voltage by +/- 1000 V, causing the image to go in and out of focus.) Any side to side or up and down motion, however, indicates that the aperture is not directly in line with the source and ion beam. This type of motion must be eliminated.

2-6. Eliminate most of the wobble using the aperture adjustment arrows in the Aperture Control popup. (The small arrows[2] on the right and upper side.)

---

[1] MicroMill HT systems do not have the wobble function: you must turn the lens 2 knob on the knob panel (back and forth) to go in and out of focus by several hundred volts.

[2] Always approach alignment of the aperture using the small arrows; if you overshoot, move the aperture back the other way.

NOTE: Use the small arrows in the positive x and y directions to fine-tune the aperture location. If you go past an optimal position using the small arrows, re-track the aperture past the optimal location in the opposite direction using the large control arrow, and then use the small arrow to fine tune the aperture location again.

2-7. Find the best location for the aperture, based on the elimination of image wobble, then set the new coordinates in memory.

a. Select *Settings* in the Aperture Control popup to display the Aperture Settings Popup.

b. Note the original x and y settings displayed in the popup versus the new settings shown in the aperture positioning screen. Make note of the amount of offset in each direction, x and y, because it is likely that the offset will carry through for each of the remaining apertures.

c. Click the *Save* button next to the coordinates on the Position line, shown in Figure 4.

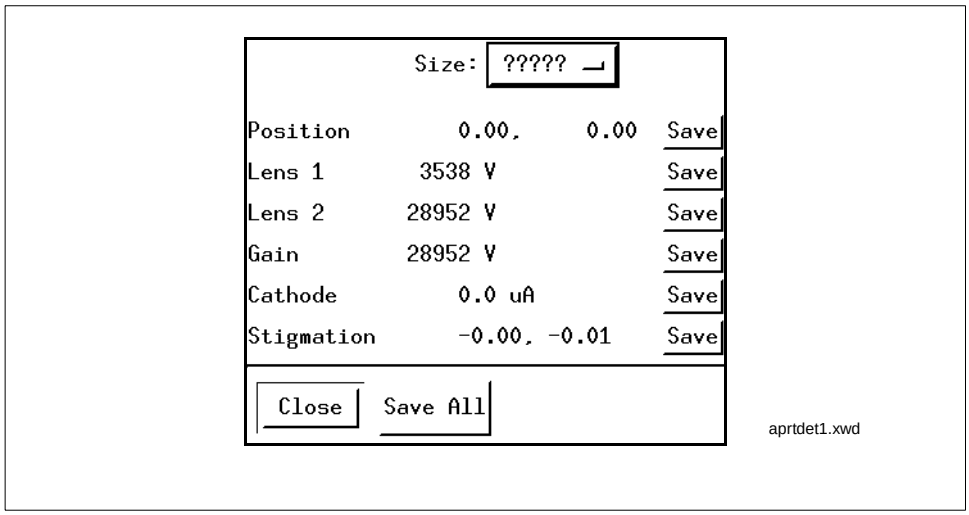


Figure 4. Aperture Setting Popup.

2-8. Click on the ion source schematic symbol to display the Ion Source Popup. Turn on *L1 Wobble*[3]. Look for up/down or side-to-side movement of the grid intersection. (For 10 nm and 25 nm columns, the wobble function varies the L1 voltage by +/- 500 V.)

NOTE: The wobble function causes the image to go in and out of focus; however, any side to side or up and down motion indicates that the beam is not passing through the center of L1. Eliminate the wobble in the image using the column adjustment screws.

2-9. Repeat steps 2-7 and 2-8 as many times as necessary to eliminate all wobble in the image.

[3] MicroMill HT systems do not have the wobble function: you must turn the lens 2 knob on the knob panel (back and forth) to go in and out of focus.

Part 3. Aligning the Remaining Apertures

Follow the procedures outlined in Part 2. Any significant x and/or y offset in aligning the aperture will probably carry through to the other apertures.

Align all remaining apertures to the source using the aperture adjustment arrows—*do not move the source*. If you move the source after aligning any aperture, you must begin the procedure again.

Micrion

Service Procedure No.: **05-14**
Service Procedure Title: **Drift Test**
Applicable Systems: **8000, Micrion 9800 FlipChip**
Frequency of Service: **As needed**

Introduction

The drift test program first mills a user-defined cross on a blank chrome plate. In a defined number of iterations, the program then scans the four ends of the cross and reports the deviation, or drift, of the centers of the two axes. If there is a drift--of either the stage or the beam--it will be seen in the output illustrated in Fig. 1:

This procedure assumes the following:

- Chrome blank plate is in the workchamber
- System is pumped down and operational
- Xterm window is open

If the drift is less than 0.25 μm in ten minutes, the drift is acceptable.

Materials Required

Clean, unscratched, chrome blank plate.

The graphical user interface for the drift test program is shown in Fig. 1.

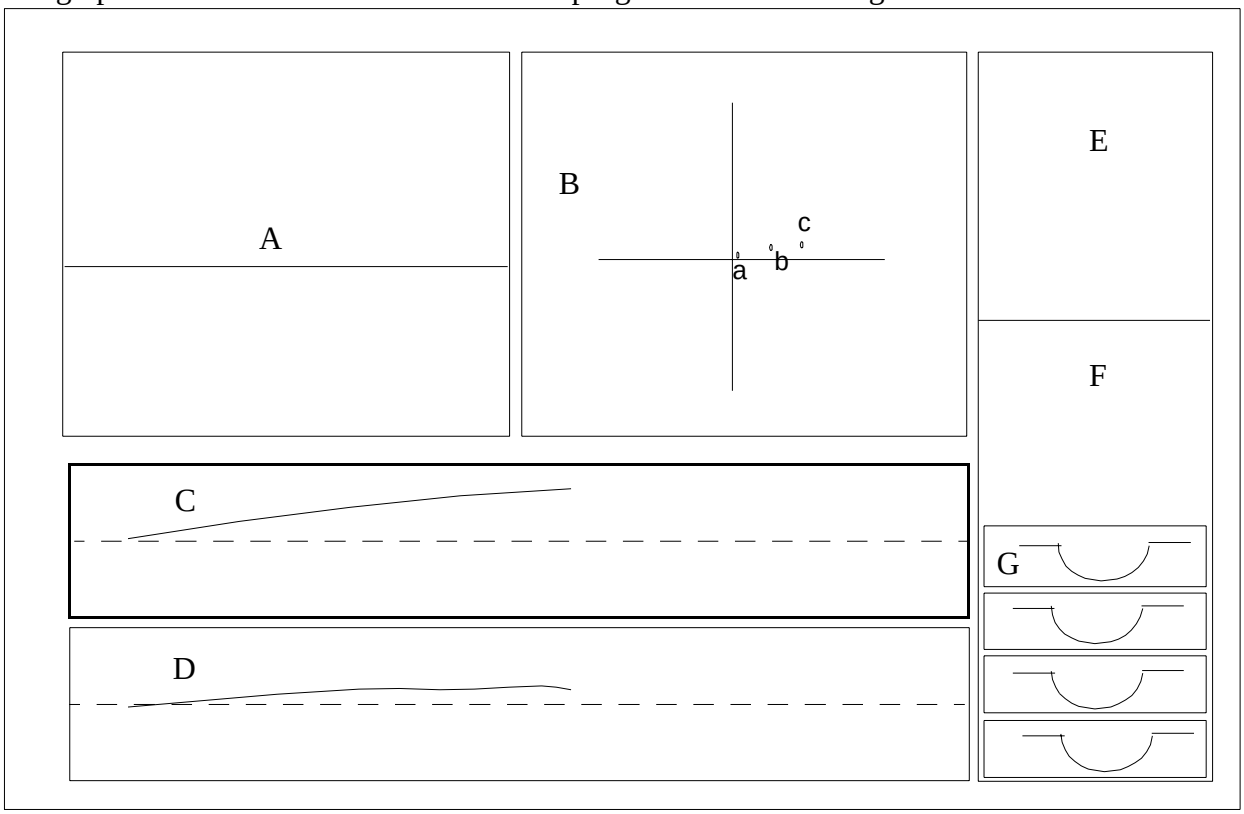


Figure 1. Drift Test Graphical User Interface

Table 1 defines the areas of the graphical user interface.

Table 1: Definition of GUI Shown in Fig. 1

Area	Name	Description
A	USER DEFINED	Shows setup for current drift test at the top of this area; lists statistics for current drift test at bottom
B	SCATTER PLOT	Shows the drift as a scatter plot; example shown in Fig. 1 illustrates drift in Figs 3, 4, and 5.
C	DEVIATION IN X	X drift in the scatter plot shown in detail
D	DEVIATION IN Y	Y drift in the scatter plot shown in detail
E	CONTROL PANEL	Allows for control of current plot
F	STATUS BAR	Shows status of current drift test; once the drift test is finished, the status bar becomes a control bar: you can scan through all the time segments of the test and see the deviations replayed in C&D.
G	RAW DATA PLOTS	One plot for each end of the cross

Part 1. Running the Drift Test

1-1. In Microsurgery, image the working area several times to clear the chrome.

1-2. Set FOV to 20 μm.

1-3. In an xterm window, type:

```
drifttest
```

1-4. To edit or create a configuration file, select *Edit Configuration*.

1-5. Enter the beam and the dose parameters in the Drift Test Conditions. Sample parameters are:

a.	Beam Step Size	5.2	nm
b.	Beam Dwell Time	10	sec
c.	Cross Width	0.5	μm
d.	Cross Dose	1.0	$nC/\mu m^2$

1-6. Enter the Time Segment parameter; three time segments should do the job. You can change beam blanking and stage compensation in each time segment to help you determine whether it is the beam or the stage that is drifting.

a. Time Segment Index 3 ---

Three time segments are recommended; they are incremented automatically

b. Reregistration Interval 60 sec

The frequency with which the program returns to the original cross.

c. Segment Test Time 5 min

d. Beam Blanking Enabled/Disabled

e. Stage Compensation Enabled/Disabled

8000 only (with laser interferometer)

f. Threshold Value in Percent 50

The system calculates the distance from the surface of the sample to the depth of the milled etch, and takes as a threshold value a user-defined percentage of that depth (50% is the default). The system calculates the width of the etch from the threshold points and finds the center of the etch.

1-7. With the Condition and Time Segment parameters edited, select *Save Configuratio*n.

g. With a file selected, click on *Etch Cross*. This initial cross is used as a "reregistration" reference (see step 1-6b).

1-8. In the lower right corner of the window, there are four Raw Data images of the scan profile. Adjust the contrast and brightness for high contrast.

1-9. During the test and after, check the Drift Statistics for deviation: current, min, and max.

Fig. 2 shows the milled cross. The arrows point to the Y axis ends of the cross, which are shown in detail in Figs 3, 4, and 5.

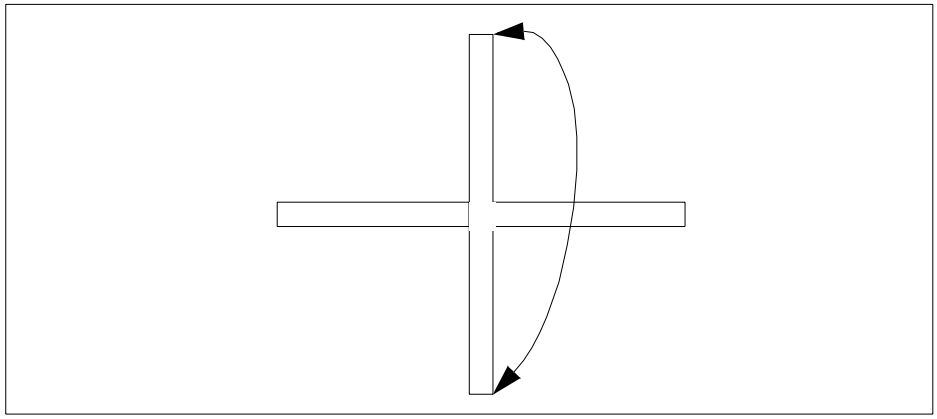


Figure 2. The Milled Cross, with Y-axis Ends Called Out

Fig. 3 shows an artist's rendition of the first scan. The program calculates the threshold, and determines from the threshold the width of the mill and the center of the mill.

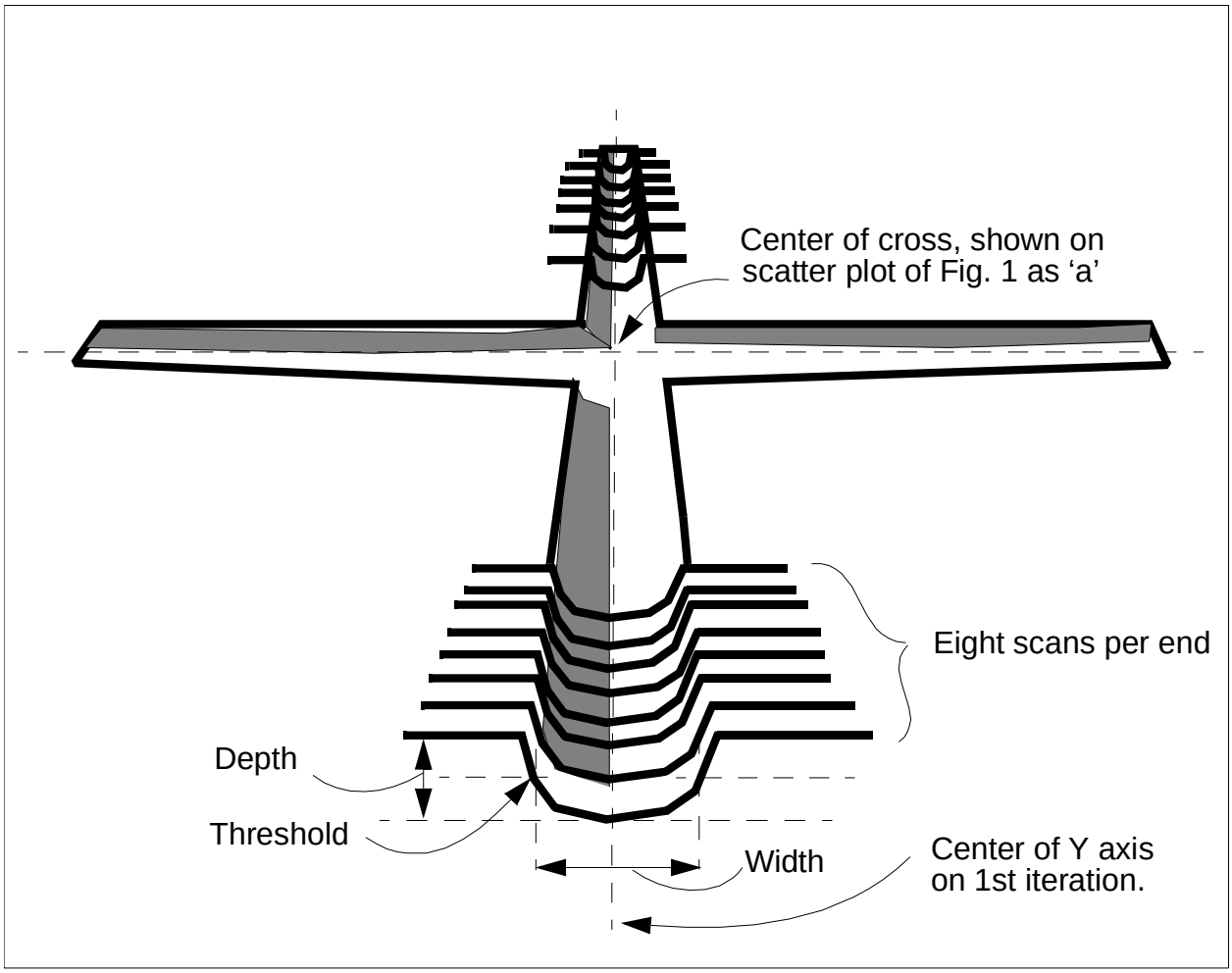


Figure 3. First Iteration of Scans on Upper and Lower Ends of Y Axis

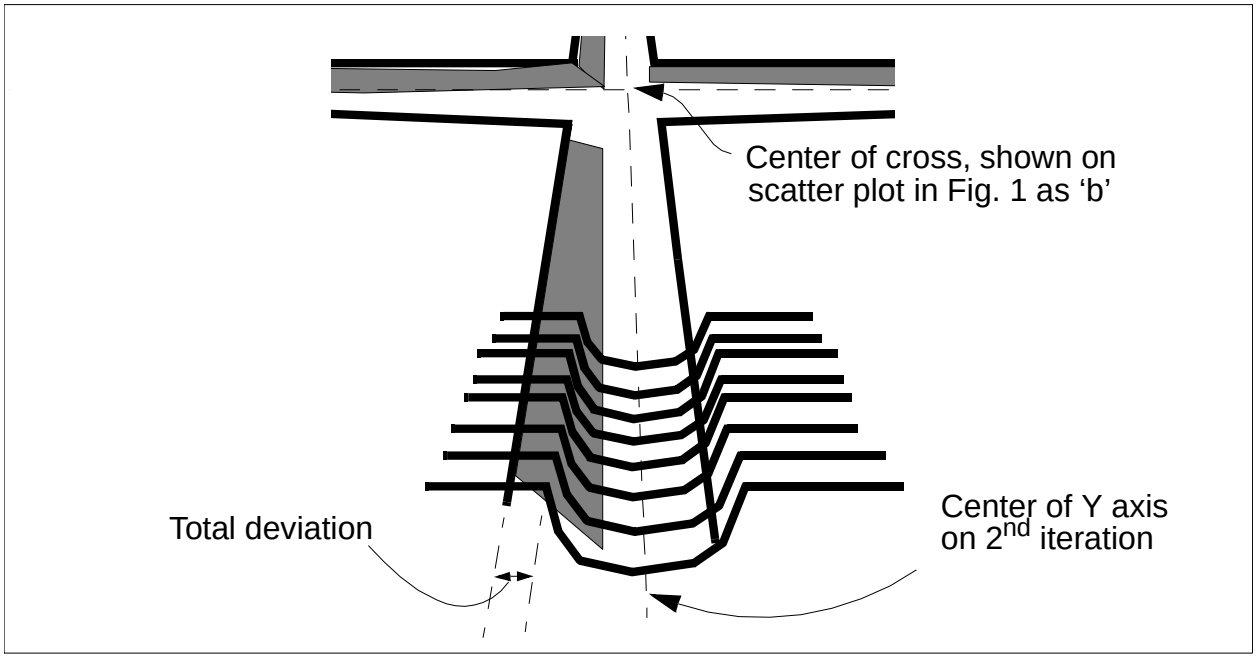


Figure 4. 2nd Iteration of Scans on Upper and Lower Ends of Cross

Compare the center of the cross in Fig. 3 with the center of the cross in Fig. 4. As you can see by the relative distance of the Y axis from the shaded portion of the drawing, there is a drift along the X axis.

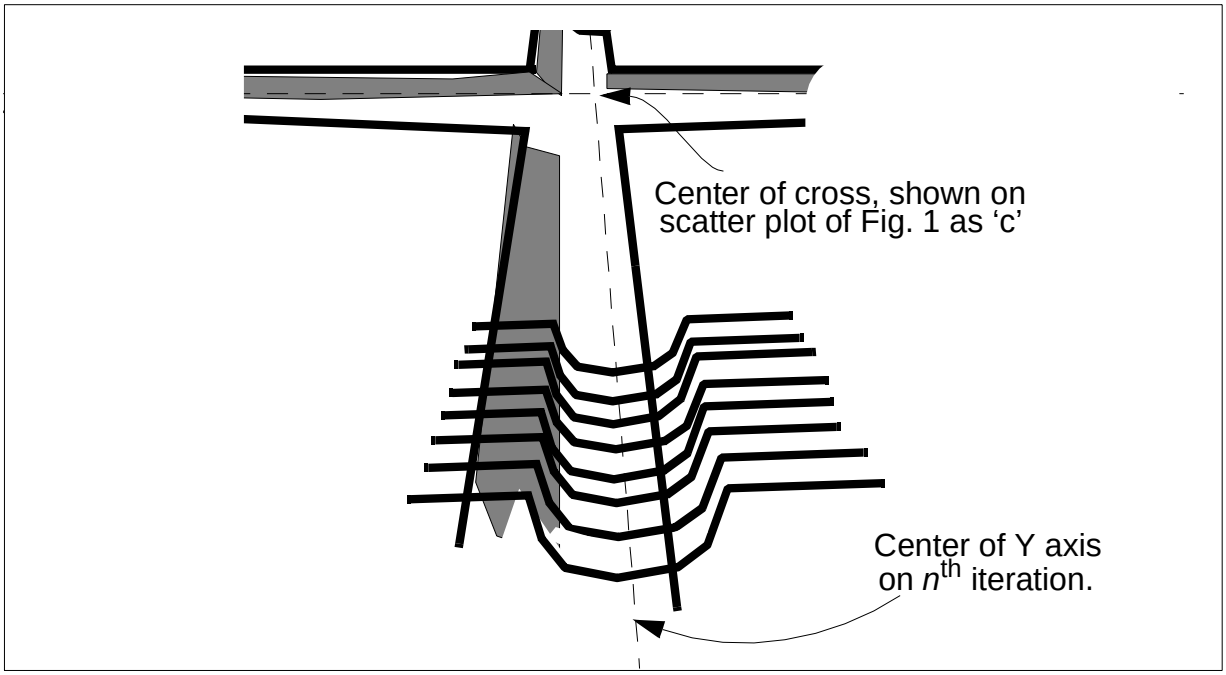


Figure 5. *N*th Iteration of Scans on Upper and Lower Ends of Cross

Fig. 5 shows iteration *n* of the drift test, with the drift continuing in the positive x direction.

Part 2. Evaluating the Drift Test

If the drift is greater than 0.25 μm in ten minutes, then you should survey the site for the following sources of vibration:

- Vibrations transferred from the floor
- Acoustic vibrations
- Electro-magnetic interference

Micrion

Service Procedure No.: 05-15-05
Service Procedure Title: Aperture Shield Removal, Inspection, & Replacement: 5 nm Column
Applicable Systems: 8000, Micrion 9800 FlipChip, MicroMill HT
Frequency of Service: As Needed

Introduction

The spray aperture shield is constructed of solid tungsten. During normal operation, the aperture shield is sputtered by the ion beam. tungsten is used because the atoms that are back-sputtered from the tungsten onto the source do not degrade the source performance (in fact, they enhance source performance). Over time, however, the beam will sputter through the tungsten. When these atoms are back-sputtered onto the ion source, they cause source instability and eventual source failure. This procedure describes the process of removing, inspecting, and replacing the aperture shield in a FIB System.

This procedure should be performed if the aperture shield has been in use for one year, or sooner if the source is not stable. In the case of source instability, try heating the source (Service Procedure 05-11) before replacing the shield.

Materials Required

This procedure requires the use of the following materials:

- Clean, standard field service tool kit
- Lint-free wipes
- Clean-room gloves
- Laboratory-grade isopropyl alcohol

NOTICE

Per paragraph 11.1 of Safety Guidelines for Semiconductor Manufacturing Equipment (S2-93), this procedure is a Type 3 task. Specifically: "Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are less than 30 volts RMS, 42.2 volts peak, 240 volt-amps, and 20 Joules."

Part1. System Preparation

Configure the Chemical Sources in "Safe" Mode

Before performing the tasks described in this procedure, you must put the chemical sources in a "safe" mode; see Service Procedure 02-01.

WARNING

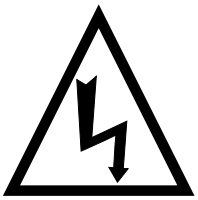
Do not proceed until the chemical sources are secure. The chemical reservoirs in FIB systems contain hazardous materials. Labels affixed to the exterior of a chemical cabinet identify the chemical(s) contained inside. If a chemical source is not in its "safest" state, as described in **Service Procedure 02-01**, it is possible for a combination of component failures to release the chemical(s) through a cabinet's delivery line, a roughing line, a purging line, or from a chemical reservoir into the workchamber. Do not open the workchamber, or disassemble any part of the vacuum pumping system, or detach any gas line from any chemical cabinet until you are sure that every chemical source attached to the FIB system is in its "safest" state.

Clean the exterior of the system as described in Service Procedure 06-05.

Power Down and Vent the System

Before performing the tasks described in this procedure, you must power down and vent the system; see Service Procedure 01-02.

WARNING



Dangerously high voltages are present in the process module while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and automatic procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

Part 2. Remove the Column Cap (Ion Gun)

Double check to see that the high voltage power supply is off, then remove all high and low voltage cables (see Figure 1).

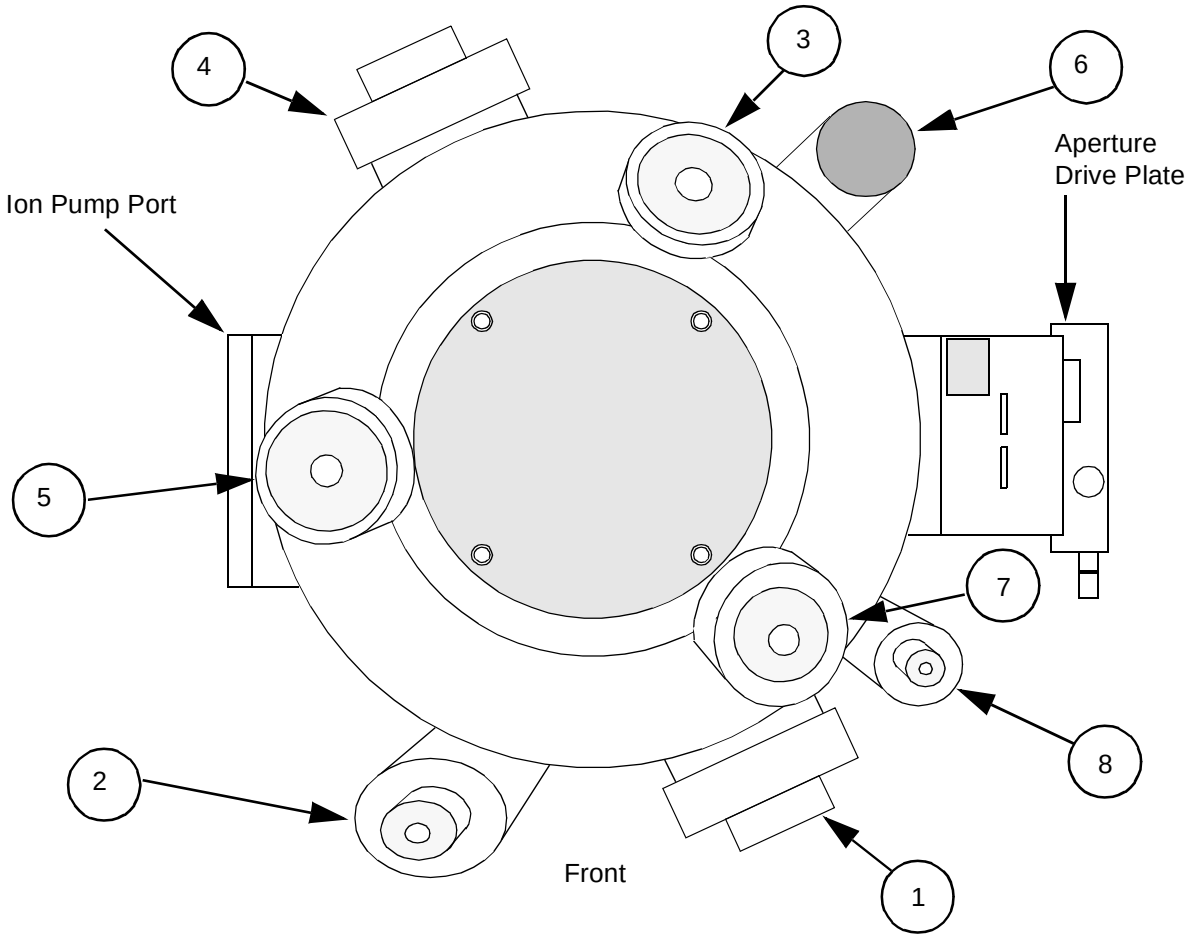


Table 1:

	Column Connections	Signal Name
1	(High Voltage)	L1 (Lens 1)
2	(High Voltage)	L2 (Lens 2)
3	(High Voltage)	S (Suppressor)
4	(High Voltage)	E (Extractor)
5	(High Voltage)	F1 (Filament)
6	(Low Voltage)	J1901 (Bbaper, octopoles)
7	(High Voltage)	F2 (Filament)
8	(Low Voltage)	Blanking Signals

Figure 1. Top View: Ion Beam Column with Power Connections

WEAR GLOVES, DO NOT HANDLE SOLVENTS

When working inside the chamber or when handling any components that will be exposed to vacuum, wear gloves rated for Class 100 environments or better. Due to disintegration of such gloves by solvents, do not handle solvents or parts that are wet with solvent.

Note: it is not necessary to open the workchamber to perform this procedure.

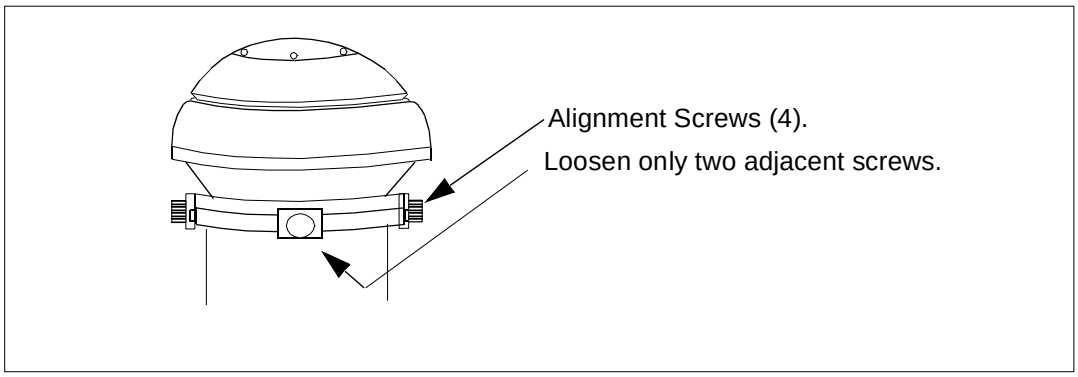


Figure 2. Location of Alignment Screws for the Column Cap Assembly.

2-1. Loosen only *two adjacent* alignment screws on the column cap (ion gun) assembly; this is done so that the ion gun alignment is minimally affected (see Figure 2).

CAUTION

Use care when lifting and moving the column cap assembly. The column cap assembly weighs approximately 25 pounds (11 kg). If necessary to avoid personal injury, secure the help of another person.

2-2. For the best leverage in removing the column cap assembly, stand behind the process module. Lift the column cap assembly straight up off the column and gently place it (top side up) on a clean work surface. **Note:** The bottom surface of the column cap assembly serves as both a registration and an O-ring surface, and is susceptible to damage from nicks and scratches.

Part 3. Remove the Extractor Cap and the Aperture Shield

3-1. Rotate the extractor cap approximately 1/3 turn and pull it past the ball detents in the extractor cap holder (the ball detents are spring-loaded ball-plungers). Lift the cap out of the holder (see Figure 3).

NOTICE

Take care not to drop the extractor cap, aperture shield, or the aperture shield screws into the column. The column would have to be removed and possibly disassembled to retrieve this hardware.

3-2. Use a small slotted screwdriver to remove the two aperture shield screws (see Figure 3). Remove the aperture shield.

Part 4. Inspect the Aperture Shield

4-1. If there are holes sputtered through the aperture shield (other than the central hole for the ion beam), it must be replaced. Even if there are no obvious holes in the aperture shield, inspect both sides of the shield for shallow depressions; depressions indicate that the Tungsten has been eroded (sputtered) and that the aperture shield should be replaced. When in doubt, replace the aperture shield, especially if it has been in an operational column for an extended period (6 to 12 months).

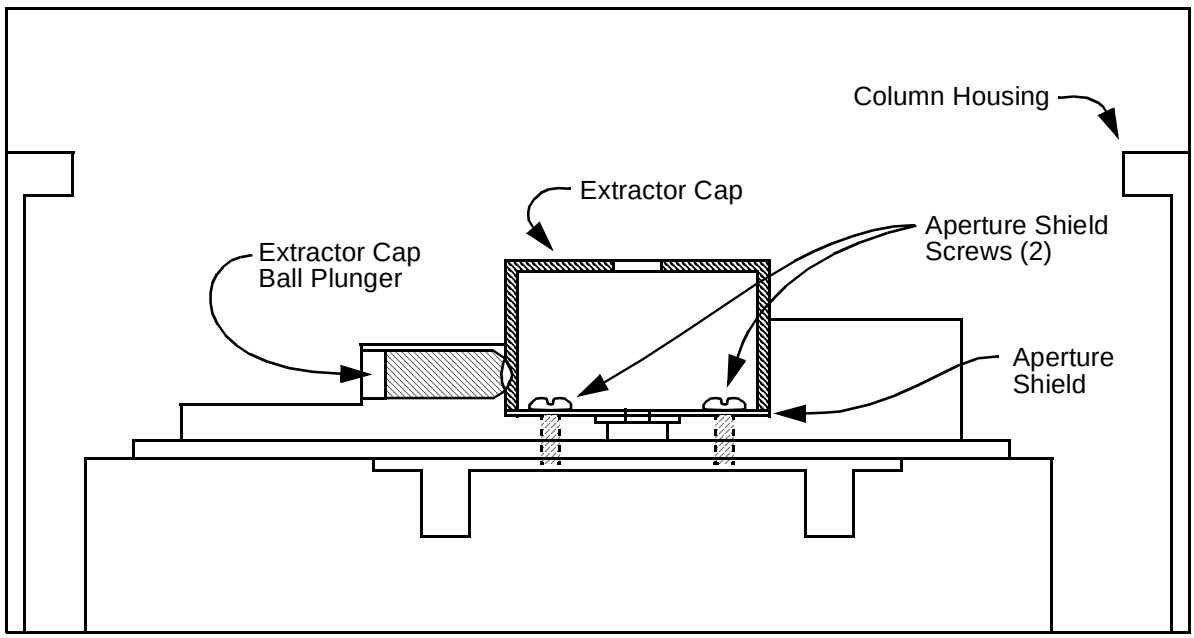


Figure 3. Cross Section of Extractor Cap and Aperture Shield

Part 5. Replace the Aperture Shield and the Extractor Cap

5-1. Fasten the replacement aperture shield to the bottom of the extractor cap holder with the two aperture shield screws (see Figure 3). The center bores of the aperture shield and the aperture must be concentric (centrally aligned), otherwise the extractor cap will not seat properly.

5-2. Align the slots on the extractor cap with the detents on the extractor cap holder and press the extractor cap into place.

Part 6. Replace the Column Cap

CAUTION

Use care when lifting and moving the column cap assembly. The column cap assembly weighs approximately 25 pounds (11 kg). If necessary to avoid personal injury, secure the help of another person.

6-1. Position the column cap assembly over the column and gently place it on the column housing. Rotate the column cap as needed for proper alignment.

6-2. Tighten the two alignment screws that were initially loosened.

6-3. Making sure that the pin is centered, connect the circular connector to the Deflection input.

6-4. After cleaning the cable ends with isoproyl and allowing them to dry, connect all high voltage cables and signal cables to the column (see Figure 1).

NOTICE: AVOID BENDING PINS

Be careful when reconnecting the 3-pin and 20-pin connectors. The pins are easily bent.

6-5. Close the workchamber and pump down the system (see Service Procedure 04-03).

6-6. Enable the high voltage power supplies.

6-7. Cure the column (see Service Procedure 05-12-05).

6-8. Heat the ion source (see Service Procedure 05-11).

6-9. Calibrate the deflection control system, as described in Section 7 of this manual, beginning with Service Procedure 07-02.

Micrion

Service Procedure No.: 05-15-10
Service Procedure Title: Aperture Shield Removal, Inspection, & Replacement: 10 nm Column
Applicable Systems: 8000, Micrion 9800 FlipChip, MicroMill HT
Frequency of Service: Annually, or As Needed.

Introduction

The spray aperture shield is constructed of solid tungsten. During normal operation, the aperture shield is sputtered by the ion beam. tungsten is used because the atoms that are back-sputtered from the tungsten onto the source do not degrade the source performance (in fact, they enhance source performance). Over time, however, the beam will sputter through the tungsten. When these atoms are back-sputtered onto the ion source, they cause source instability and eventual source failure. This procedure describes the process of removing, inspecting, and replacing the aperture shield in a FIB System.

This procedure should be performed if the aperture shield has been in use for one year, or sooner if the source is not stable. In the case of source instability, try heating the source (Service Procedure 05-11) before replacing the shield.

Materials Required

This procedure requires the use of the following materials:

- Clean, standard field service tool kit
- Lint-free wipes
- Clean-room gloves
- Laboratory-grade isopropyl alcohol

NOTICE

Per paragraph 11.1 of Safety Guidelines for Semiconductor Manufacturing Equipment (S2-93), this procedure is a Type 3 task. Specifically: "Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are less than 30 volts RMS, 42.2 volts peak, 240 volt-amps, and 20 Joules."

Part1. System Preparation

Configure the Chemical Sources in "Safe" Mode

Before performing the tasks described in this procedure, you must put the chemical sources in a "safe" mode; see Service Procedure 02-01.

WARNING

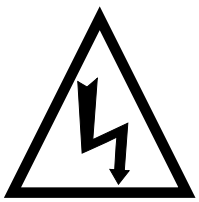
Do not proceed until the chemical sources are secure. The chemical reservoirs in FIB systems contain hazardous materials. Labels affixed to the exterior of a chemical cabinet identify the chemical(s) contained inside. If a chemical source is not in its "safest" state, as described in **Service Procedure 02-01**, it is possible for a combination of component failures to release the chemical(s) through a cabinet's delivery line, a roughing line, a purging line, or from a chemical reservoir into the workchamber. Do not open the workchamber, or disassemble any part of the vacuum pumping system, or detach any gas line from any chemical cabinet until you are sure that every chemical source attached to the FIB system is in its "safest" state.

Clean the exterior of the system as described in Service Procedure 06-05.

Power Down and Vent the System

Before performing the tasks described in this procedure, you must power down and vent the system; see Service Procedure 01-02.

WARNING



Dangerously high voltages are present in the process module while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and automatic procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

Part 2. Remove the Column Cap (Ion Gun)

Double check to see that the high voltage power supply is off, then remove all high and low voltage cables (see Figure 1).

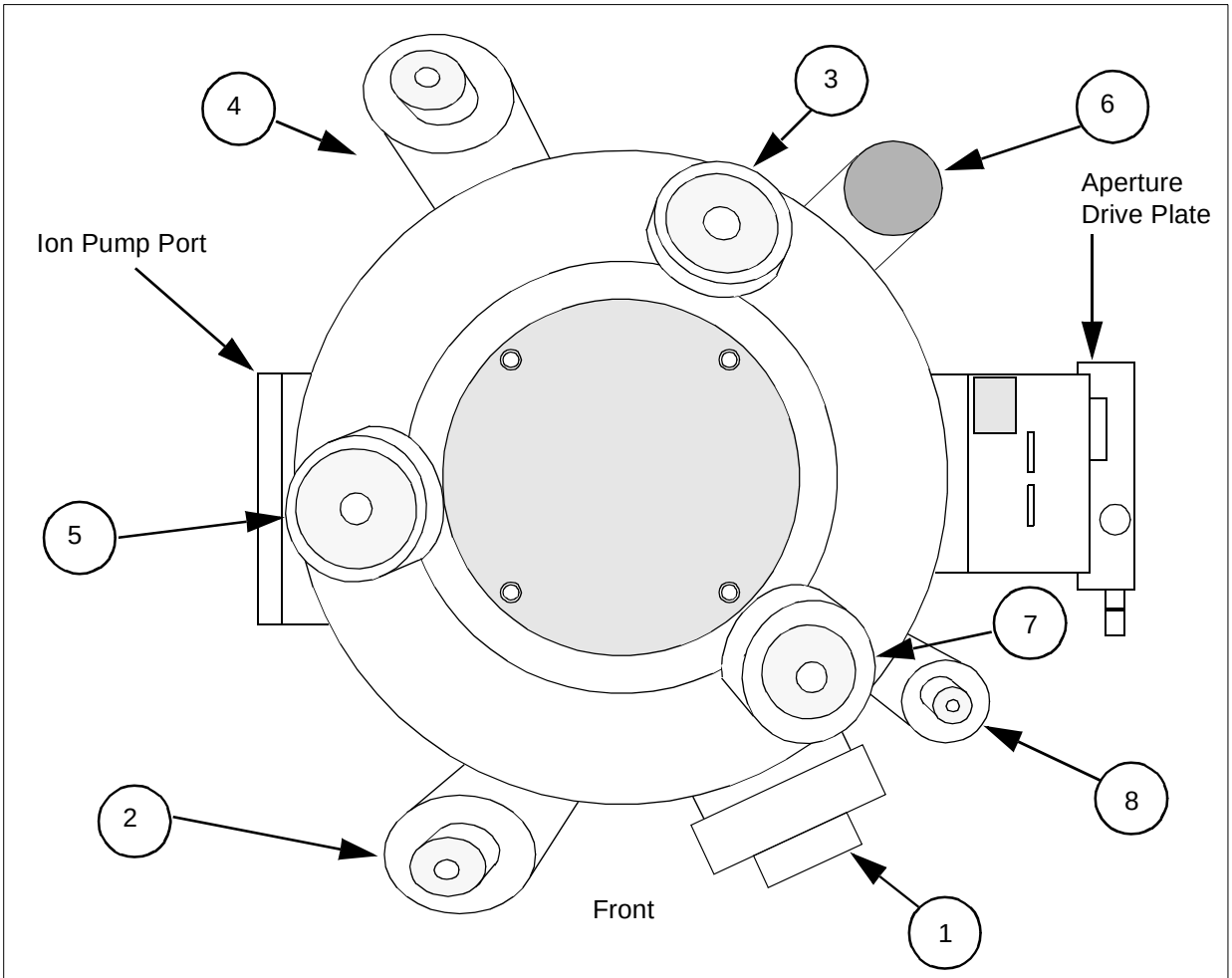


Table 1:

	Column Connections	Signal Name
1	(High Voltage)	L1 (Lens 1)
2	(High Voltage)	L2 (Lens 2)
3	(High Voltage)	F2 (Filament)
4	(High Voltage)	E (Extractor)
5	(High Voltage)	S (Suppressor)
6	(Low Voltage)	J1901 (Bbaper, octopoles)
7	(High Voltage)	F1 (Filament)
8	(Low Voltage)	Blanking Signals

Figure 1. Top View: Ion Beam Column with Power Connections

WEAR GLOVES, DO NOT HANDLE SOLVENTS

When working inside the chamber or when handling any components that will be exposed to vacuum, wear gloves rated for Class 100 environments or better. Due to disintegration of such gloves by solvents, do not handle solvents or parts that are wet with solvent.

Note: it is not necessary to open the workchamber to perform this procedure.

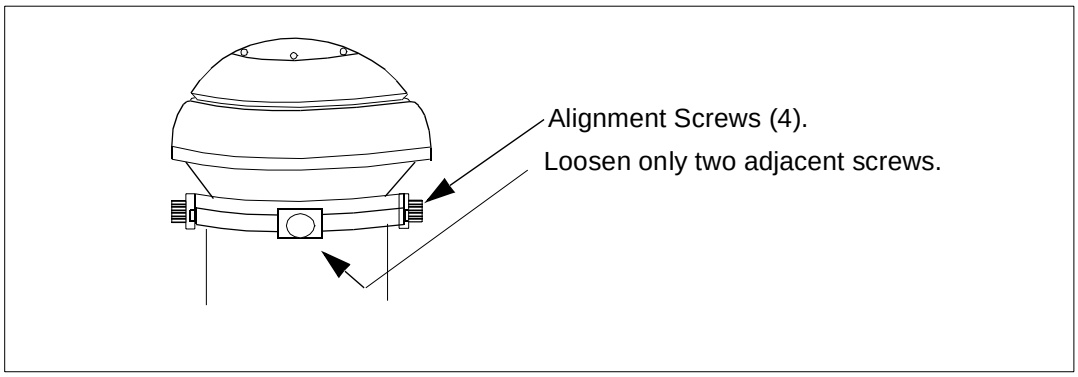


Figure 2. Location of Alignment Screws for the Column Cap Assembly.

2-1. Loosen only *two adjacent* alignment screws on the column cap (ion gun) assembly; this is done so that the ion gun alignment is minimally affected (see Figure 2).

CAUTION

Use care when lifting and moving the column cap assembly. The column cap assembly weighs approximately 25 pounds (11 kg). If necessary to avoid personal injury, secure the help of another person.

2-2. For the best leverage in removing the column cap assembly, stand behind the process module. Lift the column cap assembly straight up off the column and gently place it (top side up) on a clean work surface. **Note:** The bottom surface of the column cap assembly serves as both a registration and an O-ring surface, and is susceptible to damage from nicks and scratches.

Part 3. Remove the Extractor Cap and the Aperture Shield

3-1. Rotate the extractor cap approximately 1/3 turn and pull it past the ball detents in the extractor cap holder (the ball detents are spring-loaded ball-plungers). Lift the cap out of the holder (see Figure 3).

NOTICE

Take care not to drop the extractor cap, aperture shield, or the aperture shield screws into the column. The column would have to be removed and possibly disassembled to retrieve this hardware.

3-2. Use a small slotted screwdriver to remove the two aperture shield screws (see Figure 3). Remove the aperture shield.

Part 4. Inspect the Aperture Shield

4-1. If there are holes sputtered through the aperture shield (other than the central hole for the ion beam), it must be replaced. Even if there are no obvious holes in the aperture shield, inspect both sides of the shield for shallow depressions; depressions indicate that the Tungsten has been eroded (sputtered) and that the aperture shield should be replaced. When in doubt, replace the aperture shield, especially if it has been in an operational column for an extended period (6 to 12 months).

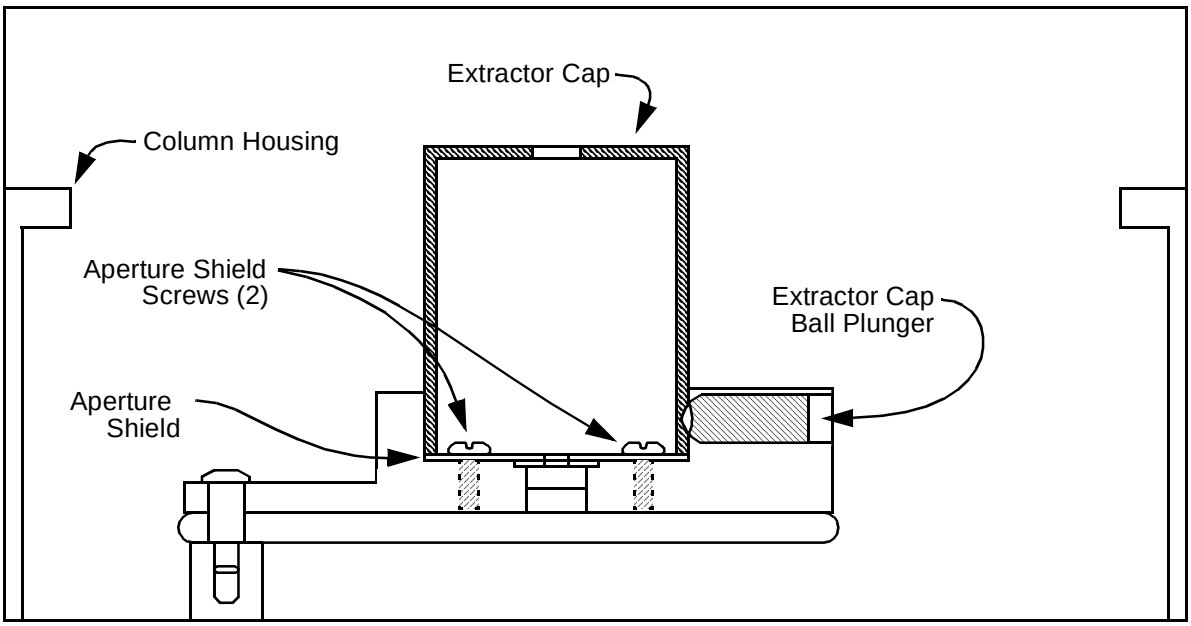


Figure 3. Cross Section of Extractor Cap and Aperture Shield

Part 5. Replace the Aperture Shield and the Extractor Cap

5-1. Fasten the replacement aperture shield to the bottom of the extractor cap holder with the two aperture shield screws (see Figure 3). The center bores of the aperture shield and the aperture must be concentric (centrally aligned), otherwise the extractor cap will not seat properly.

5-2. Align the slots on the extractor cap with the detents on the extractor cap holder and press the extractor cap into place.

Part 6. Replace the Column Cap

CAUTION

Use care when lifting and moving the column cap assembly. The column cap assembly weighs approximately 25 pounds (11 kg). If necessary to avoid personal injury, secure the help of another person.

6-1. Position the column cap assembly over the column and gently place it on the column housing. Rotate it as needed for proper alignment.

6-2. Tighten the two alignment screws that were initially loosened.

6-3. Making sure that the pin is centered, connect the circular connector to the Deflection input.

6-4. After cleaning the cable ends with isoproyl and allowing them to dry, connect all high voltage cables and signal cables to the column (see Figure 1).

NOTICE: AVOID BENDING PINS

Be careful when reconnecting the 3-pin and 20-pin connectors. The pins are easily bent.

6-5. Close the workchamber and pump down the system (see Service Procedure 04-03).

6-6. Enable the high voltage power supplies.

6-7. Cure the column (see Service Procedure 05-12-10).

6-8. Heat the ion source (see Service Procedure 05-11).

6-9. Calibrate the deflection control system, as described in Section 7 of this manual, beginning with Service Procedure 07-02.

Micrion

Service Procedure No.: 05-15-25
Service Procedure Title: Aperture Shield Removal, Inspection, & Replacement: 25 nm Column
Applicable Systems: 8000, Micrion 9800 FlipChip
Frequency of Service: Annually, or As Needed.

Introduction

The spray aperture shield is constructed of solid tungsten. During normal operation, the aperture shield is sputtered by the ion beam. tungsten is used because the atoms that are back-sputtered from the tungsten onto the source do not degrade the source performance (in fact, they enhance source performance). Over time, however, the beam will sputter through the tungsten. When these atoms are back-sputtered onto the ion source, they cause source instability and eventual source failure. This procedure describes the process of removing, inspecting, and replacing the aperture shield in a FIB System.

This procedure should be performed if the aperture shield has been in use for one year, or sooner if the source is not stable. In the case of source instability, try heating the source (Service Procedure 05-11) before replacing the shield.

Materials Required

This procedure requires the use of the following materials:

- Clean, standard field service tool kit
- Lint-free wipes
- Clean-room gloves
- Laboratory-grade isopropyl alcohol

NOTICE

Per paragraph 11.1 of Safety Guidelines for Semiconductor Manufacturing Equipment (S2-93), this procedure is a Type 3 task. Specifically: "Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are less than 30 volts RMS, 42.2 volts peak, 240 volt-amps, and 20 Joules."

Part1. System Preparation

Configure the Chemical Sources in "Safe" Mode

Before performing the tasks described in this procedure, you must put the chemical sources in a "safe" mode; see Service Procedure 02-01.

WARNING

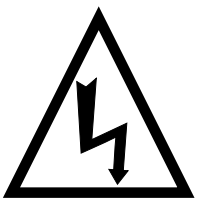
Do not proceed until the chemical sources are secure. The chemical reservoirs in FIB systems contain hazardous materials. Labels affixed to the exterior of a chemical cabinet identify the chemical(s) contained inside. If a chemical source is not in its "safest" state, as described in **Service Procedure 02-01**, it is possible for a combination of component failures to release the chemical(s) through a cabinet's delivery line, a roughing line, a purging line, or from a chemical reservoir into the workchamber. Do not open the workchamber, or disassemble any part of the vacuum pumping system, or detach any gas line from any chemical cabinet until you are sure that every chemical source attached to the FIB system is in its "safest" state.

Clean the exterior of the system as described in Service Procedure 06-05.

Power Down and Vent the System

Before performing the tasks described in this procedure, you must power down and vent the system; see Service Procedure 01-02.

WARNING



Dangerously high voltages are present in the process module while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and automatic procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

Part 2. Remove the Column Cap (Ion Gun)

Double check to see that the high voltage power supply is off, then remove all high and low voltage cables (see Figure 1).

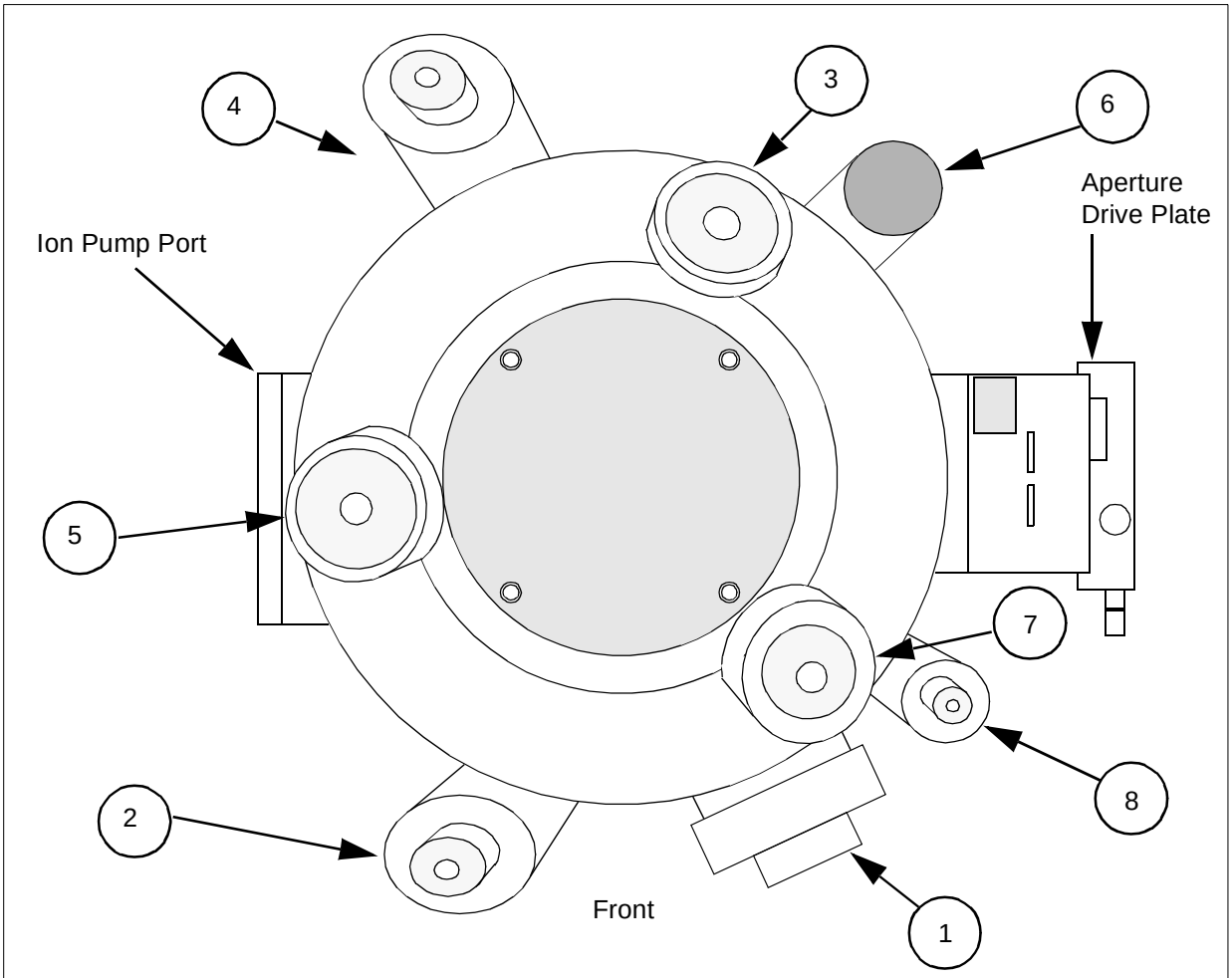


Table 1:

	Column Connections	Signal Name
1	(High Voltage)	L1 (Lens 1)
2	(High Voltage)	L2 (Lens 2)
3	(High Voltage)	F2 (Filament)
4	(High Voltage)	E (Extractor)
5	(High Voltage)	S (Suppressor)
6	(Low Voltage)	J1901 (Bbaper, octopoles)
7	(High Voltage)	F1 (Filament)
8	(Low Voltage)	Blanking Signals

Figure 1. Top View: Ion Beam Column with Power Connections

WEAR GLOVES, DO NOT HANDLE SOLVENTS

When working inside the chamber or when handling any components that will be exposed to vacuum, wear gloves rated for Class 100 environments or better. Due to disintegration of such gloves by solvents, do not handle solvents or parts that are wet with solvent.

Note: it is not necessary to open the workchamber to perform this procedure.

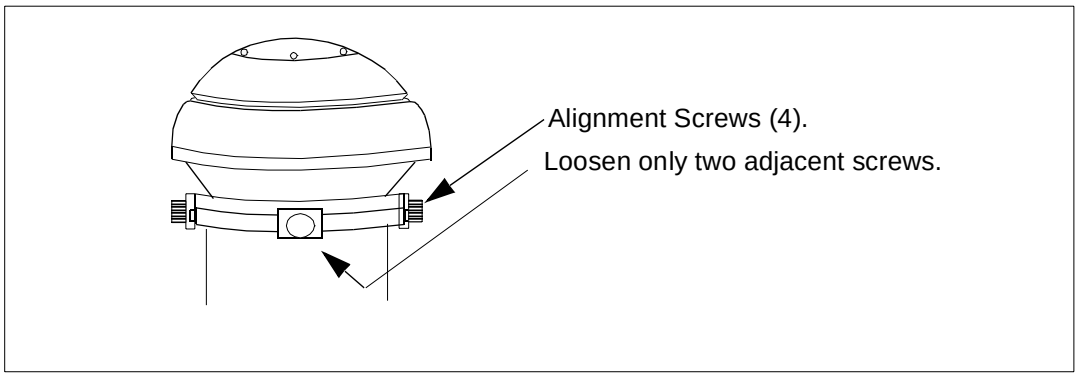


Figure 2. Location of Alignment Screws for the Column Cap Assembly.

2-1. Loosen only *two adjacent* alignment screws on the column cap (ion gun) assembly; this is done so that the ion gun alignment is minimally affected (see Figure 2).

CAUTION

Use care when lifting and moving the column cap assembly. The column cap assembly weighs approximately 25 pounds (11 kg). If necessary to avoid personal injury, secure the help of another person.

2-2. For the best leverage in removing the column cap assembly, stand behind the process module. Lift the column cap assembly straight up off the column and gently place it (top side up) on a clean work surface. **Note:** The bottom surface of the column cap assembly serves as both a registration and an O-ring surface, and is susceptible to damage from nicks and scratches.

Part 3. Remove the Extractor Cap and the Aperture Shield

3-1. Rotate the extractor cap approximately 1/3 turn and pull it past the ball detents in the extractor cap holder (the ball detents are spring-loaded ball-plungers). Lift the cap out of the holder (see Figure 3).

NOTICE

Take care not to drop the extractor cap, aperture shield, or the aperture shield screws into the column. The column would have to be removed and possibly disassembled to retrieve this hardware.

3-2. Use a small slotted screwdriver to remove the two aperture shield screws (see Figure 3). Remove the aperture shield.

Part 4. Inspect the Aperture Shield

4-1. If there are holes sputtered through the aperture shield (other than the central hole for the ion beam), it must be replaced. Even if there are no obvious holes in the aperture shield, inspect both sides of the shield for shallow depressions; depressions indicate that the Tungsten has been eroded (sputtered) and that the aperture shield should be replaced. When in doubt, replace the aperture shield, especially if it has been in an operational column for an extended period (6 to 12 months).

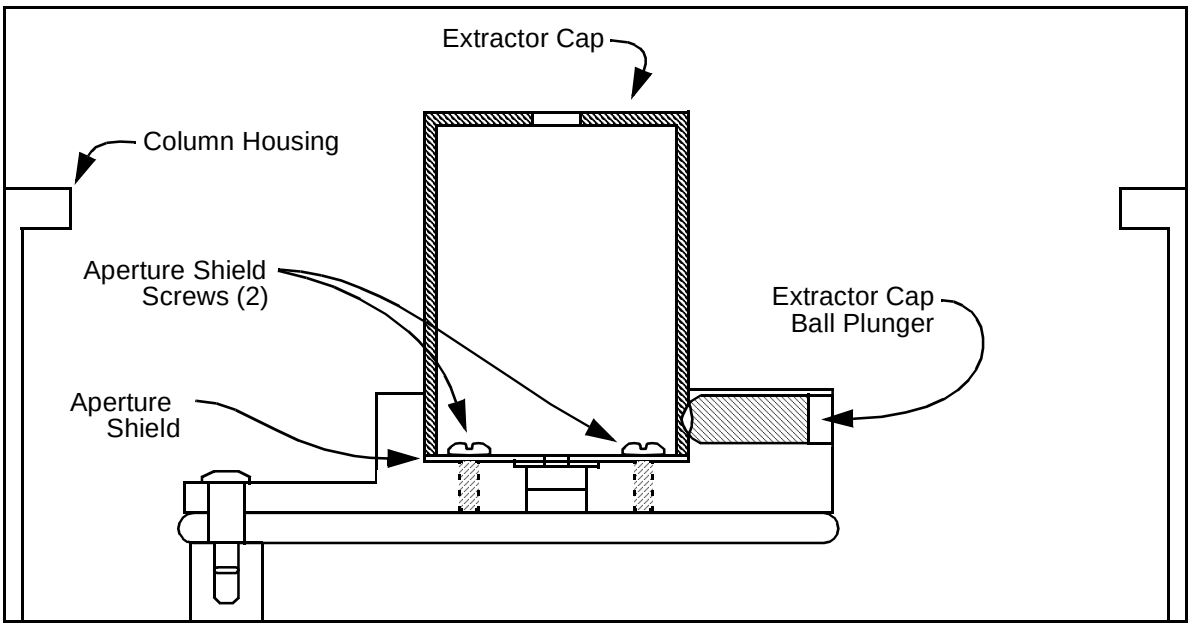


Figure 3. Cross Section of Extractor Cap and Aperture Shield

Part 5. Replace the Aperture Shield and the Extractor Cap

5-1. Fasten the replacement aperture shield to the bottom of the extractor cap holder with the two aperture shield screws (see Figure 3). The center bores of the aperture shield and the aperture must be concentric (centrally aligned), otherwise the extractor cap will not seat properly.

5-2. Align the slots on the extractor cap with the detents on the extractor cap holder and press the extractor cap into place.

Part 6. Replace the Column Cap

CAUTION

Use care when lifting and moving the column cap assembly. The column cap assembly weighs approximately 25 pounds (11 kg). If necessary to avoid personal injury, secure the help of another person.

6-1. Position the column cap assembly over the column and gently place it on the column housing. Rotate it as needed for proper alignment.

6-2. Tighten the two alignment screws that were initially loosened.

6-3. Making sure that the pin is centered, connect the circular connector to the Deflection input.

6-4. After cleaning the cable ends with isoproyl and allowing them to dry, connect all high voltage cables and signal cables to the column (see Figure 1).

NOTICE: AVOID BENDING PINS

Be careful when reconnecting the 3-pin and 20-pin connectors. The pins are easily bent.

6-5. Close the workchamber and pump down the system (see Service Procedure 04-03).

6-6. Enable the high voltage power supplies.

6-7. Cure the column (see Service Procedure 05-12-25).

6-8. Heat the ion source (see Service Procedure 05-11).

6-9. Calibrate the deflection control system, as described in Section 7 of this manual, beginning with Service Procedure 07-02.

Micrion

Service Procedure No.: **05-16-05**
Service Procedure Title: **Blanking Aperture Replacement: 5 nm Column**
Applicable Systems: **8000, Micrion 9800 FlipChip, MicroMill HT**
Frequency of Service: **As Needed**

Introduction

During normal operation, the blanking aperture is sputtered by the ion beam. Over time, the beam will erode the blanking aperture. This procedure describes the process of removing and replacing the blanking aperture in a FIB system.

Required Materials

This procedure requires the following materials:

- Clean room, preferably with a class 100 airflow hood
- Clean, standard field service tools (completely free of oil and grease)
- Lint-free wipes
- Clean-room gloves
- High intensity light source
- Aluminum foil
- Clean lens brush
- Clean, filtered dry nitrogen (an ionizing N_2 gun with 20 psi pressure is preferred)
- Cotton-tipped applicators
- Acetone
- MicroMill HT only: blanking aperture upgrade kit (Micrion part number 100-14130)
- Silver paint

NOTICE

Per paragraph 11.1 of *Safety Guidelines for Semiconductor Manufacturing Equipment* (S2-93), this procedure is a Type 3 task: “Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are less than 30 volts RMS, 42.2 volts peak, 240 volt-amps, and 20 Joules.”

NOTICE: TRAINING IS REQUIRED FOR THIS PROCEDURE

Do not attempt to perform this procedure unless you have been properly trained. Only qualified personnel should perform this procedure.

Part1. System Preparation

Configure the Chemical Sources in "Safe" Mode

Before performing the tasks described in this procedure, you must put the chemical sources in a "safe" mode; see Service Procedure 02-01.

WARNING

Do not proceed until the chemical sources are secure. The chemical reservoirs in FIB systems contain hazardous materials. Labels affixed to the exterior of a chemical cabinet identify the chemical(s) contained inside. If a chemical source is not in its "safest" state, as described in **Service Procedure 02-01**, it is possible for a combination of component failures to release the chemical(s) through a cabinet's delivery line, a roughing line, a purging line, or from a chemical reservoir into the workchamber. Do not open the workchamber, or disassemble any part of the vacuum pumping system, or detach any gas line from any chemical cabinet until you are sure that every chemical source attached to the FIB system is in its "safest" state.

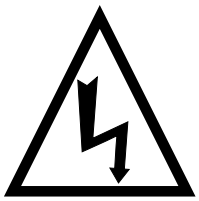
NOTICE: CLEAN THE SURROUNDING AREA

Before you vent the system, clean the exterior of the process module and the surrounding area. The column is very sensitive to contamination.

Power Down and Vent the System

Before performing the tasks described in this procedure, you must power down and vent the system; see Service Procedure 01-02.

WARNING



Dangerously high voltages are present in the process module while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and automatic procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

Part 2. Remove the Column

WEAR GLOVES, DO NOT HANDLE SOLVENTS

When working inside the chamber or when handling any components that will be exposed to vacuum, wear gloves rated for Class 100 environments or better. Due to disintegration of such gloves by solvents, do not handle solvents or parts that are wet with solvent.

2-1. Remove the column as described in Parts 1, 2, 3, and 4 of Service Procedure 05-09-05, Column Removal and Replacement: 5 nm Column. Bring the column to the clean room. Cover any openings in the workchamber with aluminum foil.

CAUTION

Use care when lifting and moving the column cap and column housing assemblies. The column cap assembly weighs approximately 25 pounds (11 kg). The column housing weighs approximately 50 pounds (28 kg). If necessary to avoid personal injury, secure the help of another person.

2-2. Place the column assembly upside down on the work surface. **Note:** two types of MCP (small and large) are installed in FIB systems with 5 nm columns: see Figures 1 and 2.

2-3. Remove the MCP from the lower shield (which is now facing up) by removing the mounting screws (and the spacers, if applicable) as shown in Figures 1 and 2. Be careful not to damage the MCP screen. Place the MCP on a clean work surface.

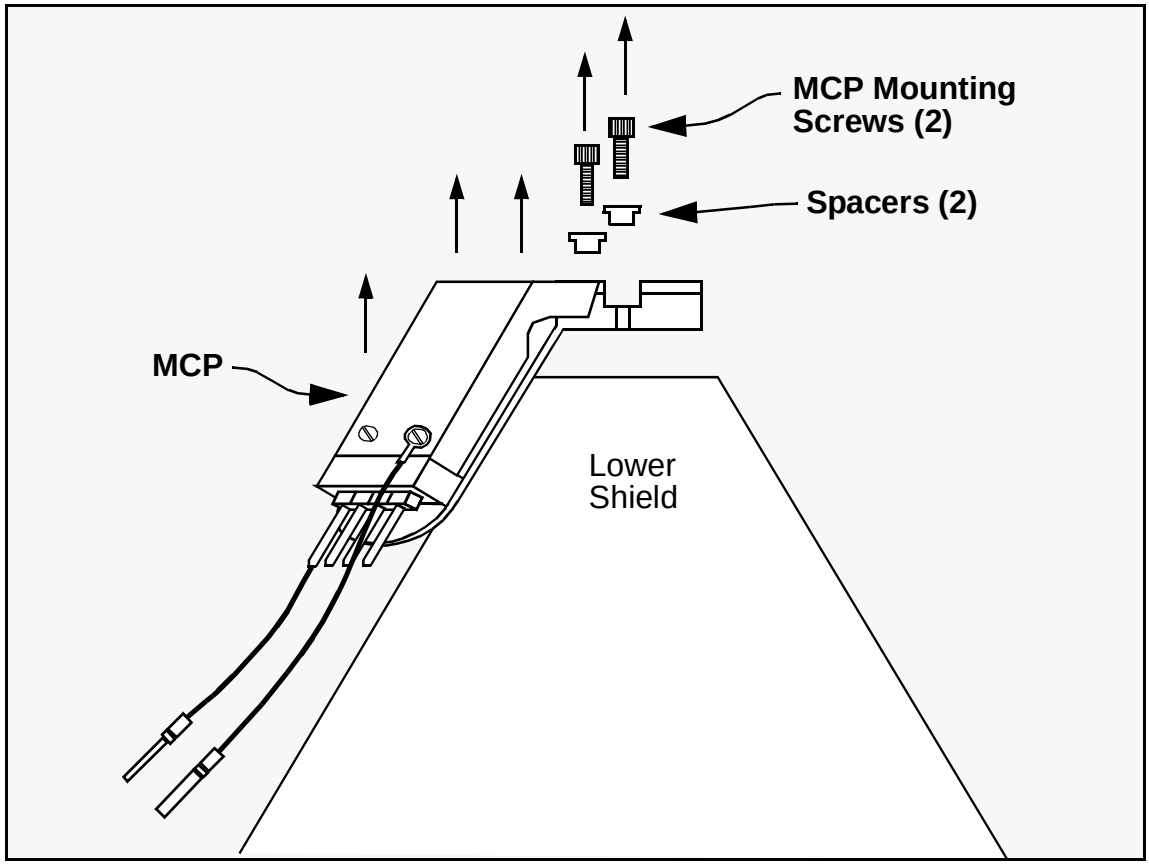


Figure 1. Removing a Small MCP

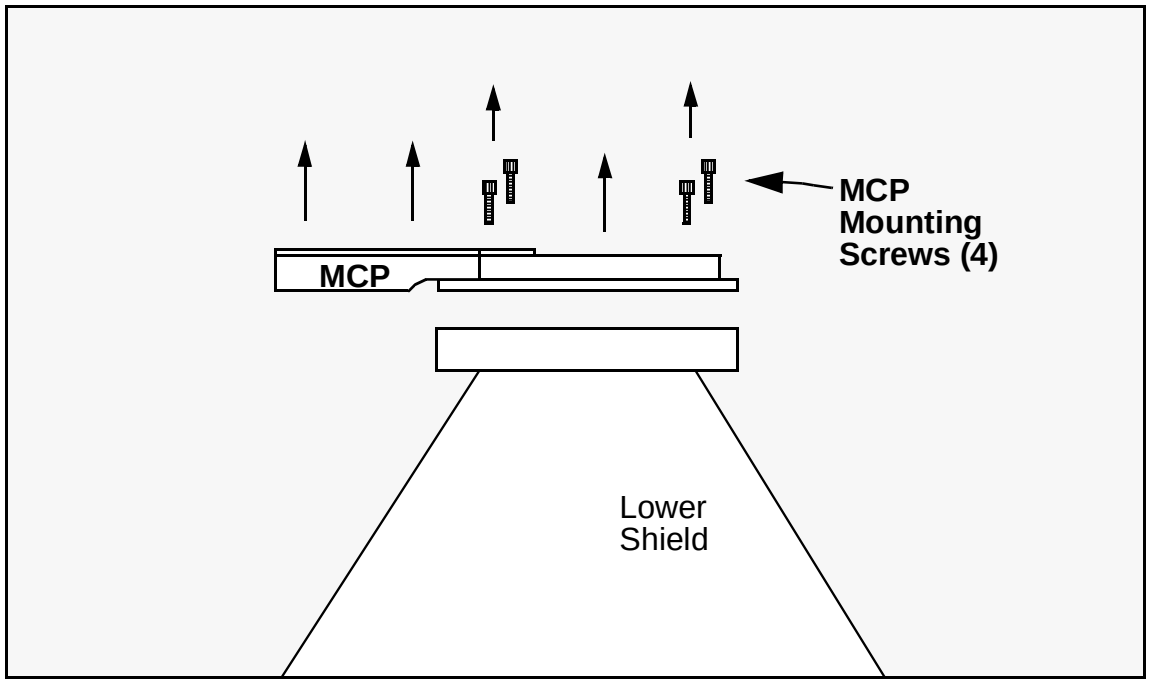


Figure 2. Removing a Large MCP

2-4. Note the rotational position of the lower shield. **The lower shield must be reinstalled in its original position for proper MCP alignment**. Remove the lower shield by loosening the three Phillips-head screws (see Figure 3).

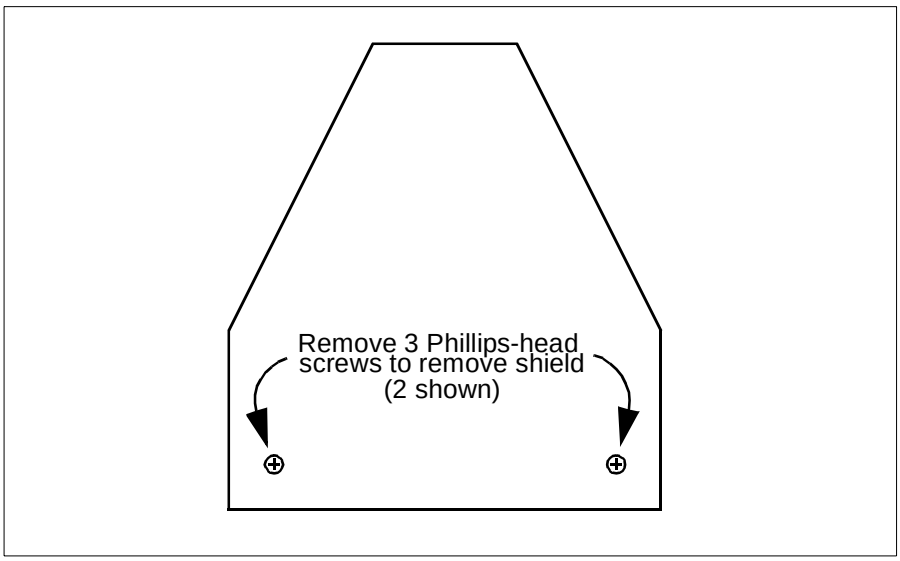


Figure 3. Side and Bottom Views of Lower Shield with Mounting Screws

NOTICE: LOWER COLUMN ELEMENTS ARE FRAGILE

Handle the lower column and its elements with great care. Any scratches will ruin the lower column (Lens 2) elements. Also, any metal tracks left on ceramic surfaces cause serious problems with the column operation.

Part 3. Remove the Lower Column Electrical Connectors

3-1. Pull the lower column electrical connectors out of the slot in the back of the lower column; there are eight pin/socket connections. The wires are color-coded. See Figure 4.

3-2. Loosen the hex head screw on the HV spacer and remove the high voltage wire from the HV spacer (See Figures 4 and 5). Cut off the kinked end of the high voltage wire (see Figure 5).

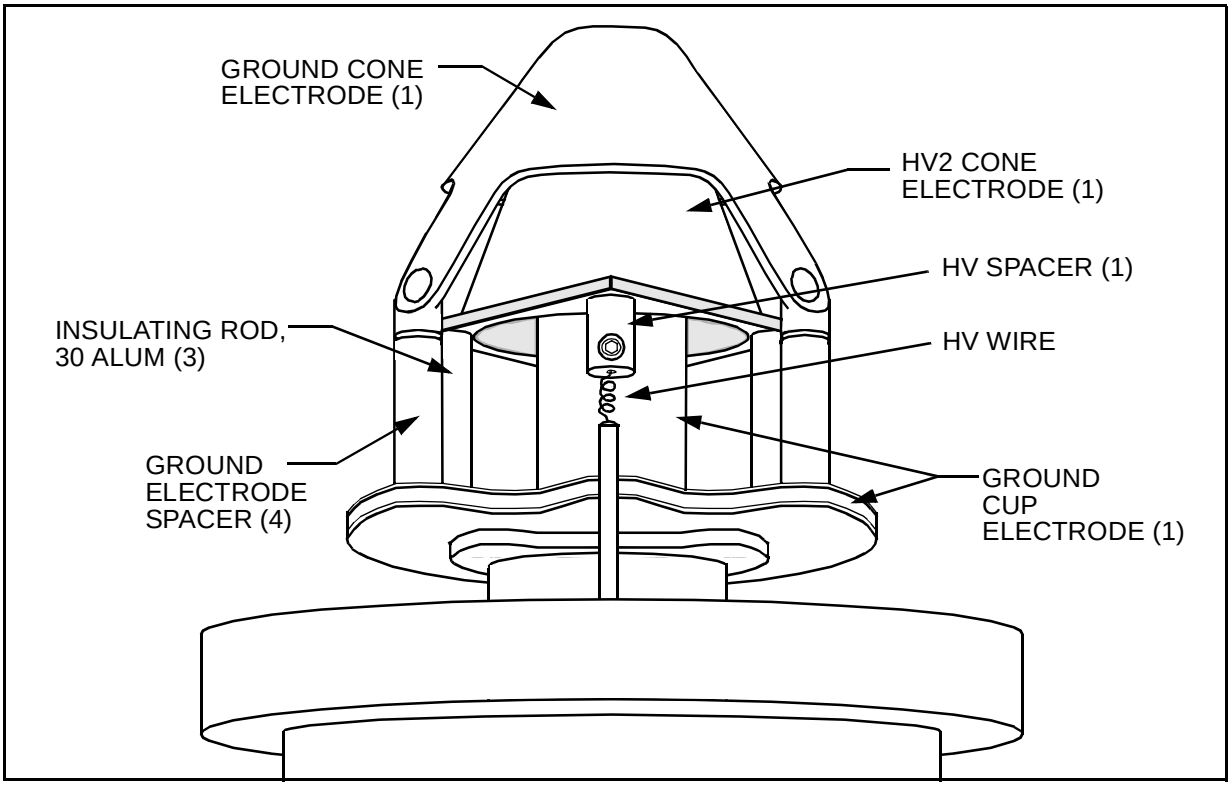


Figure 4. Lower Column (Lens 2) Without Shield

3-3. Disconnect the eight lower column electrical connectors. See Figure 5.

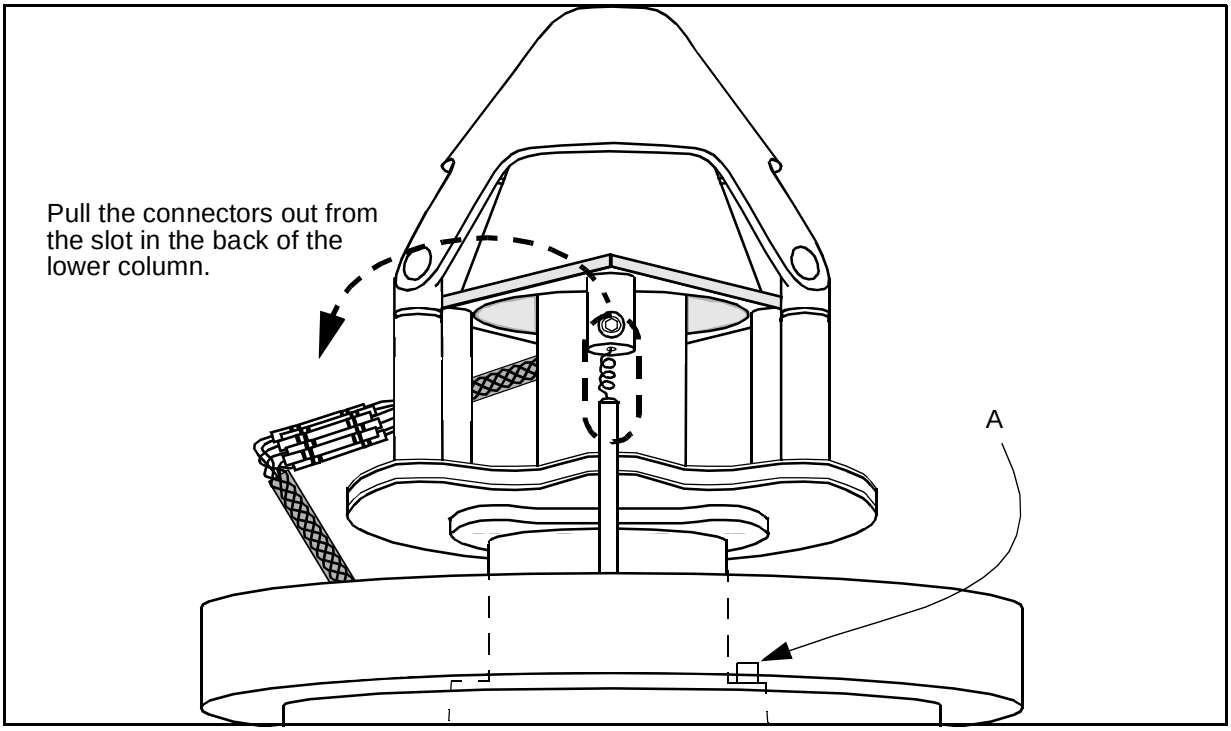


Figure 5. Lower Column Electrical Connectors

Part 4. Remove the Lower Column (Lens 2) Assembly

4-1. Remove the three screws at the base of the lower column (Lens 2) assembly (see A in Fig. 5).

4-2. Carefully lift the lower column (Lens 2) assembly straight up and out of the column to expose the end of the beam blanking assembly. Place the assembly on a clean work surface.

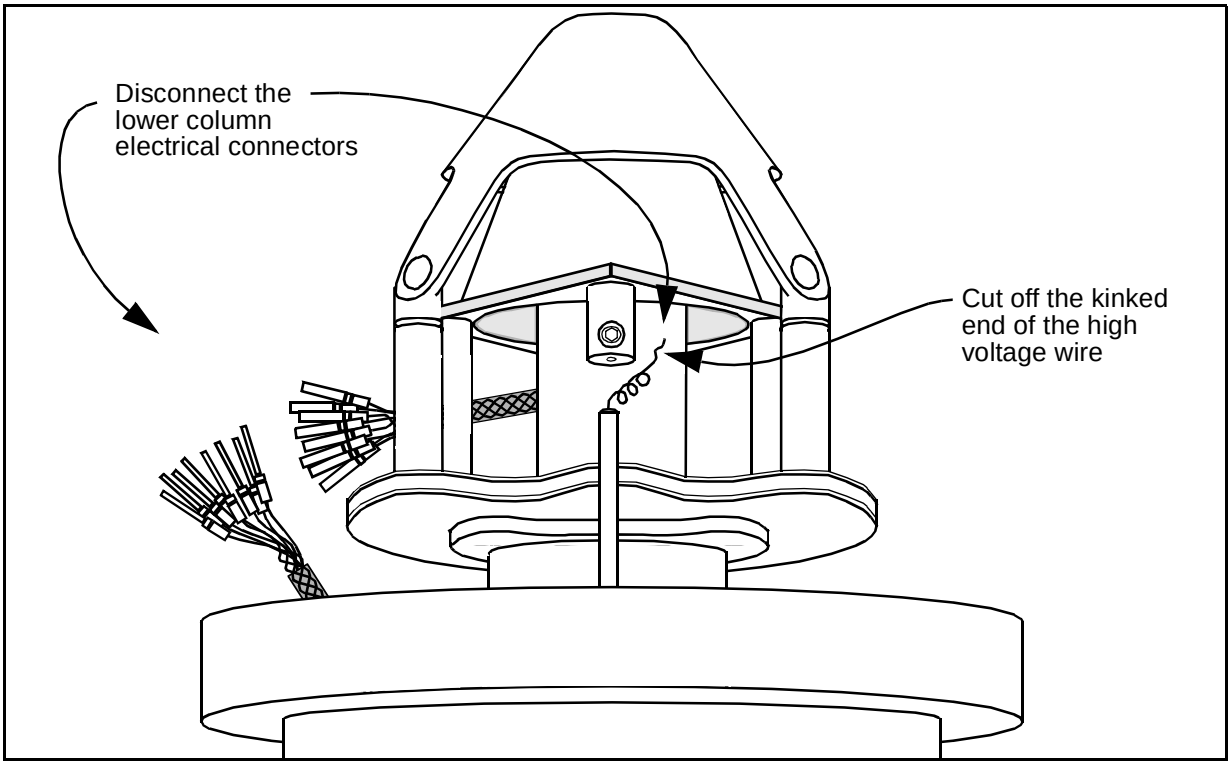


Figure 6. Disconnect the Lower Column Electrical Connectors

Part 5. Replace the Blanking Aperture: MicroMill HT FIB Systems

This method is only used in MicroMill HT systems. **For all other systems with 5 nm columns, proceed to Part 6**. Originally, silver paint was used to bond the blanking aperture to the end of the beam blanking assembly in MicroMill HT systems; that method is no longer used. The new method employs a clip (and screw) to hold a thicker blanking aperture in place (the upgrade kit is Micrion part number 100-14130).

5-1. Inspect the end of the beam blanking assembly. If the blanking aperture is held in place with a clip and screw (see Figure 7), remove the screw, clip, and blanking aperture, then proceed to step 5-5.

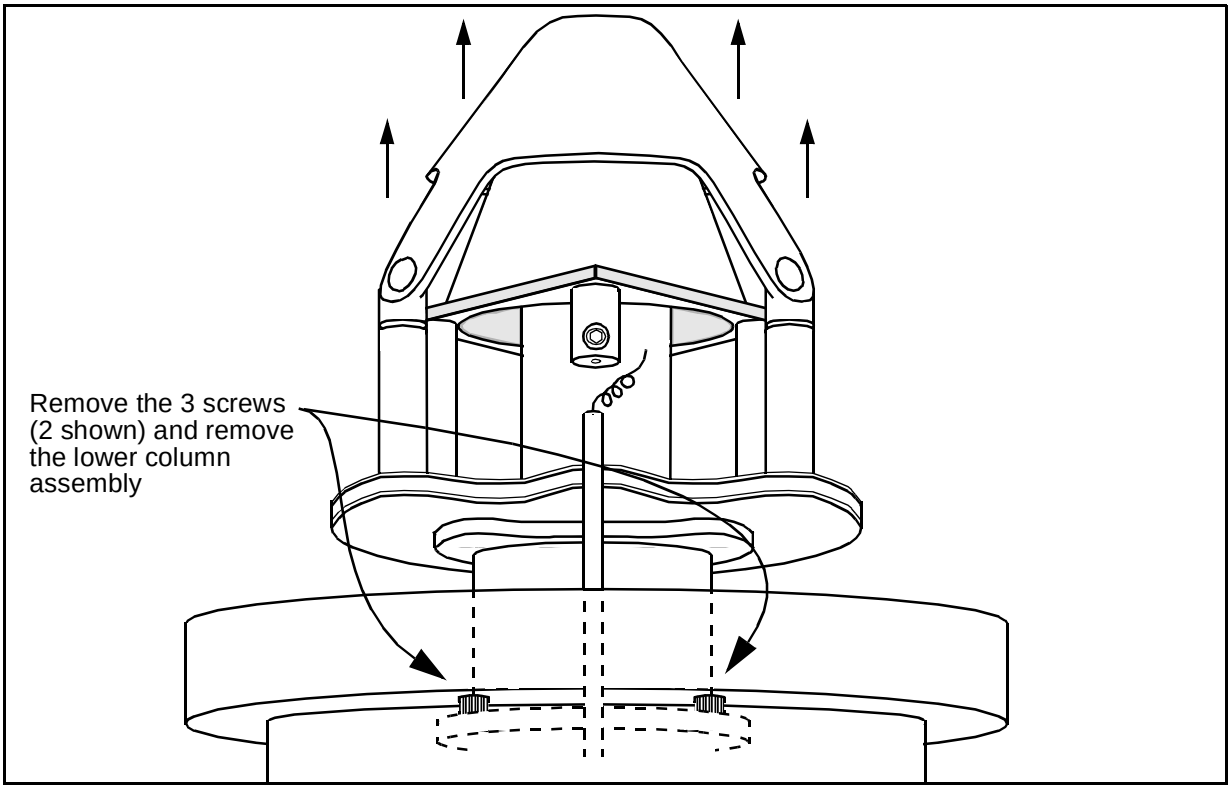


Figure 7. Remove the Lower Lens (L2) Assembly

5-2. If there is no clip on the end of the beam blanking assembly, use cotton applicators and acetone to remove the silver paint on the outside diameter of the blanking aperture.

5-3. Insert a probe into the center bore of the blanking aperture and gently pry the blanking aperture loose.

NOTICE: DO NOT CONTAMINATE THE COLUMN

When removing the silver paint from the area of the blanking aperture, do not contaminate the column with silver paint particles, acetone/silver paint residue, or other contaminants.

5-4. Use cotton applicators and acetone to clean any remaining silver paint residue from the end of the beam blanking assembly.

5-5. Place the new blanking aperture in the shallow (0.004” deep) counterbore on the end of the beam blanking assembly. The blanking aperture must be seated in the counterbore to ensure proper alignment. Place the blanking aperture clip over the blanking aperture and fasten it in place with the with the 0-80 pan head screw (see Figure 8).

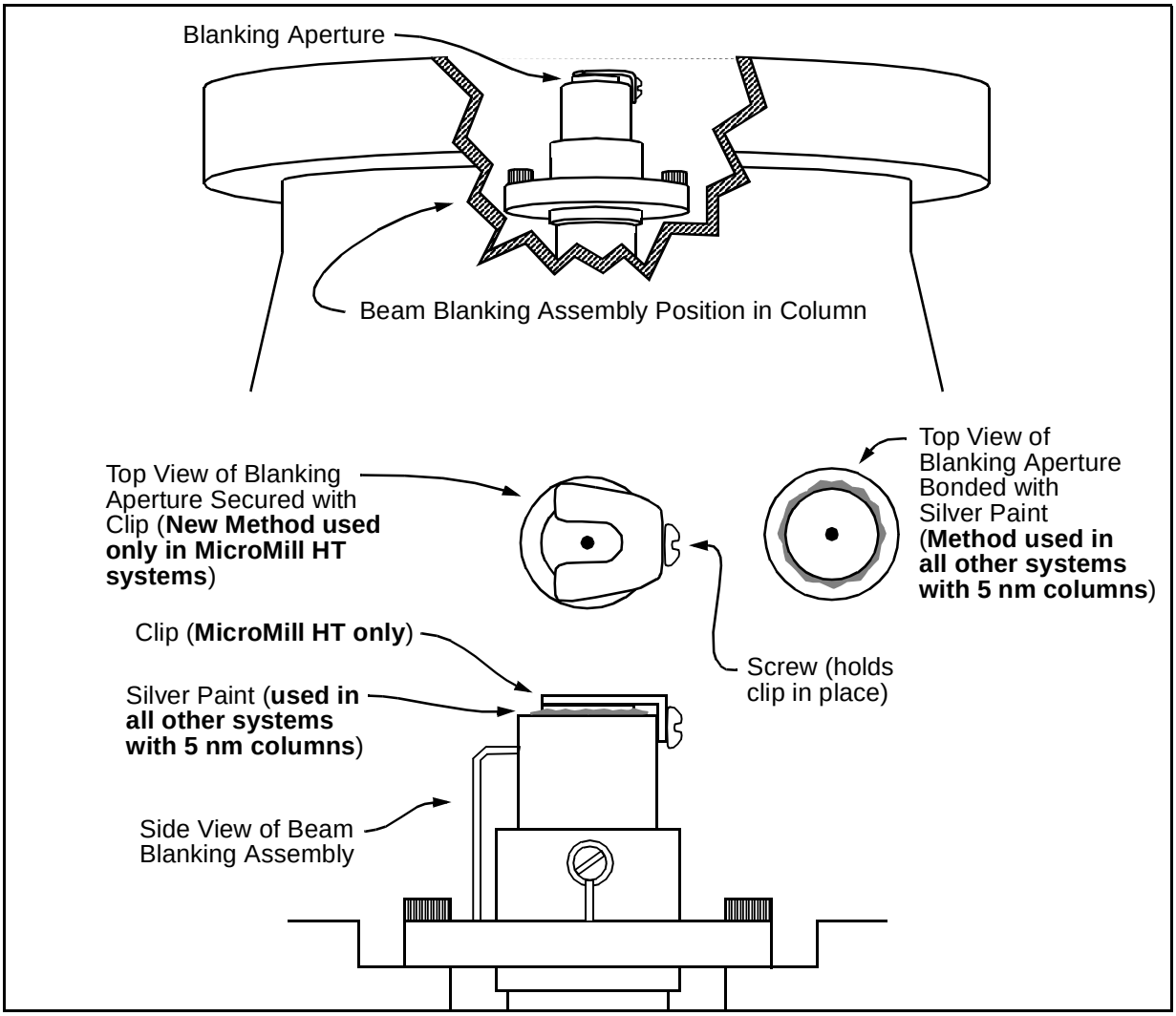

Blanking Aperture
Beam Blanking Assembly Position in Column
Top View of Blanking Aperture Secured with Clip (**New Method used only in MicroMill HT systems**)
Top View of Blanking Aperture Bonded with Silver Paint (**Method used in all other systems with 5 nm columns**)
Clip (**MicroMill HT only**)
Screw (holds clip in place)
Silver Paint (**used in all other systems with 5 nm columns**)
Side View of Beam Blanking Assembly

Figure 8. Blanking Aperture Location and Fastening Methods: 5 nm Columns

5-6. Reinstall the lower column (Lens 2) assembly (see figure 6).

5-7. Insert the high voltage wire into the hole in the HV spacer and tighten the hex head screw on the HV spacer (see Figures 3, 4, and 5).

5-8. Reconnect the lower column electrical connectors (the wires are color-coded). Tuck the connectors and wires back into the slot in the back of the lower column (see Figure 4).

Part 6. Replace the Blanking Aperture: Systems with 5 nm Columns

6-1. Use cotton applicators and acetone to remove the silver paint on the outside diameter of the blanking aperture (see Figure 7).

6-2. Insert a probe into the center bore of the blanking aperture and gently pry the blanking aperture loose.

NOTICE: DO NOT CONTAMINATE THE COLUMN

When removing the silver paint from the area of the blanking aperture, do not contaminate the column with silver paint particles, acetone/silver paint residue, or other contaminants.

6-3. Use cotton applicators and acetone to clean any remaining silver paint residue from the end of the beam blanking assembly.

6-4. Place the new blanking aperture in the shallow (0.004” deep) counterbore on the end of the beam blanking assembly. The blanking aperture must be seated in the counterbore to ensure proper alignment.

6-5. Shake the silver paint to mix it thoroughly.

NOTICE: DO NOT CONTAMINATE THE COLUMN

When applying silver paint to the outside diameter of the blanking aperture, do not contaminate the column with silver paint. Use cotton applicators and acetone to remove any spilled paint.

6-6. Use a sharp wooden pick to apply a few beads of silver paint first on four or five spots around the outside diameter of the blanking aperture. Let the paint dry for approximately 15 minutes. Check that the aperture is still in the counterbore; if it slips out, you will not be able to align the column. Then apply apply a thin bead of paint around the outside diameter and allow to dry.

6-7. Reinstall the lower column (Lens 2) assembly (see figure 6).

6-8. Insert the high voltage wire into the hole in the HV spacer and tighten the hex head screw on the HV spacer (see Figures 3, 4, and 5).

6-9. Reconnect the lower column electrical connectors (the wires are color-coded). Tuck the connectors and wires back into the slot in the back of the lower column (see Figure 4).

Part 7. Clean the Lower Column

NOTICE: LOWER COLUMN ELEMENTS ARE FRAGILE

Any scratches will ruin the lower column (Lens 2) elements. Also, any metal tracks left on ceramic surfaces cause serious problems with the column operation.

7-1. Examine the lower column for contaminants under high intensity light. Figure 3 shows the lower column elements.

Use the lens brush, cotton tipped applicators, and nitrogen to gently clean off any contaminants you find; use the nitrogen to remove contaminants from areas that you are not able to reach with the brush or cotton tipped applicators. Ground element surfaces are especially susceptible to particulate contaminants.

7-2. Clean the interior of the lower shield, the gun, and the column.

Part 8. Reassemble and Reinstall the Column

8-1. Reinstall the lower shield and MCP **in their original rotational positions**. The center bores of the lower shield and the Lens 2 assembly should be concentric (centrally aligned).

8-2. Clean the workchamber (as described in Service Procedure 06-03) and the ion pump connector tube.

8-3. Reinstall the column as described in Part 5 of Service Procedure 05-09-05, Column Removal and Replacement: 5 nm Column.

Micrion

Service Procedure No.: **05-16-10**
Service Procedure Title: **Blanking Aperture Replacement: 10 nm Column**
Applicable Systems: **8000, Micrion 9800 FlipChip**
Frequency of Service: **As Needed**

Introduction

During normal operation, the blanking aperture is sputtered by the ion beam. Over time, the beam will erode the blanking aperture. This procedure describes the process of removing and replacing the blanking aperture in a FIB system.

Required Materials

This procedure requires the following materials:

- Clean room, preferably with a class 100 airflow hood
- Clean, standard field service tools (completely free of oil and grease)
- Lint-free wipes
- Clean-room gloves
- High intensity light source
- Aluminum foil
- Clean lens brush
- Clean, filtered dry nitrogen (an ionizing N_2 gun is preferred) with sufficient pressure to blow off particles
- Cotton-tipped applicators
- Acetone
- Silver paint

NOTICE

Per paragraph 11.1 of *Safety Guidelines for Semiconductor Manufacturing Equipment* (S2-93), this procedure is a Type 3 task: “Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are less than 30 volts RMS, 42.2 volts peak, 240 volt-amps, and 20 Joules.”

NOTICE: TRAINING IS REQUIRED FOR THIS PROCEDURE

Do not attempt to perform this procedure unless you have been properly trained. Only qualified personnel should perform this procedure.

Part1. System Preparation

Configure the Chemical Sources in "Safe" Mode

Before performing the tasks described in this procedure, you must put the chemical sources in a "safe" mode; see Service Procedure 02-01.

WARNING

Do not proceed until the chemical sources are secure. The chemical reservoirs in FIB systems contain hazardous materials. Labels affixed to the exterior of a chemical cabinet identify the chemical(s) contained inside. If a chemical source is not in its "safest" state, as described in **Service Procedure 02-01**, it is possible for a combination of component failures to release the chemical(s) through a cabinet's delivery line, a roughing line, a purging line, or from a chemical reservoir into the workchamber. Do not open the workchamber, or disassemble any part of the vacuum pumping system, or detach any gas line from any chemical cabinet until you are sure that every chemical source attached to the FIB system is in its "safest" state.

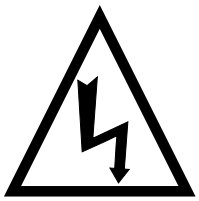
NOTICE: CLEAN THE SURROUNDING AREA

Before you vent the system, clean the exterior of the process module and the surrounding area. The column is very sensitive to contamination.

Power Down and Vent the System

Before performing the tasks described in this procedure, you must power down and vent the system; see Service Procedure 01-02.

WARNING



Dangerously high voltages are present in the process module while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and automatic procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

Part 2. Remove the Column

WEAR GLOVES, DO NOT HANDLE SOLVENTS

When working inside the chamber or when handling any components that will be exposed to vacuum, wear gloves rated for Class 100 environments or better. Due to disintegration of such gloves by solvents, do not handle solvents or parts that are wet with solvent.

2-1. Remove the column as described in Parts 1, 2, 3, and 4 of Service Procedure 05-09-10, Column Removal and Replacement: 10 nm Column. Bring the column to the clean room. Cover any openings in the workchamber with aluminum foil.

CAUTION

Use care when lifting and moving the column cap and column housing assemblies. The column cap assembly weighs approximately 25 pounds (11 kg). The column housing weighs approximately 50 pounds (28 kg). If necessary to avoid personal injury, secure the help of another person.

2-2. Place the column assembly upside down on the work surface. **Note:** two types of MCP (small and large) are installed in FIB systems with 10 nm columns: see Figures 1 and 2.

2-3. Remove the MCP from the lower shield (which is now facing up) by removing the mounting screws (and the spacers, if applicable) as shown in Figures 1 and 2. Be careful not to damage the MCP screen. Place the MCP on a clean work surface.

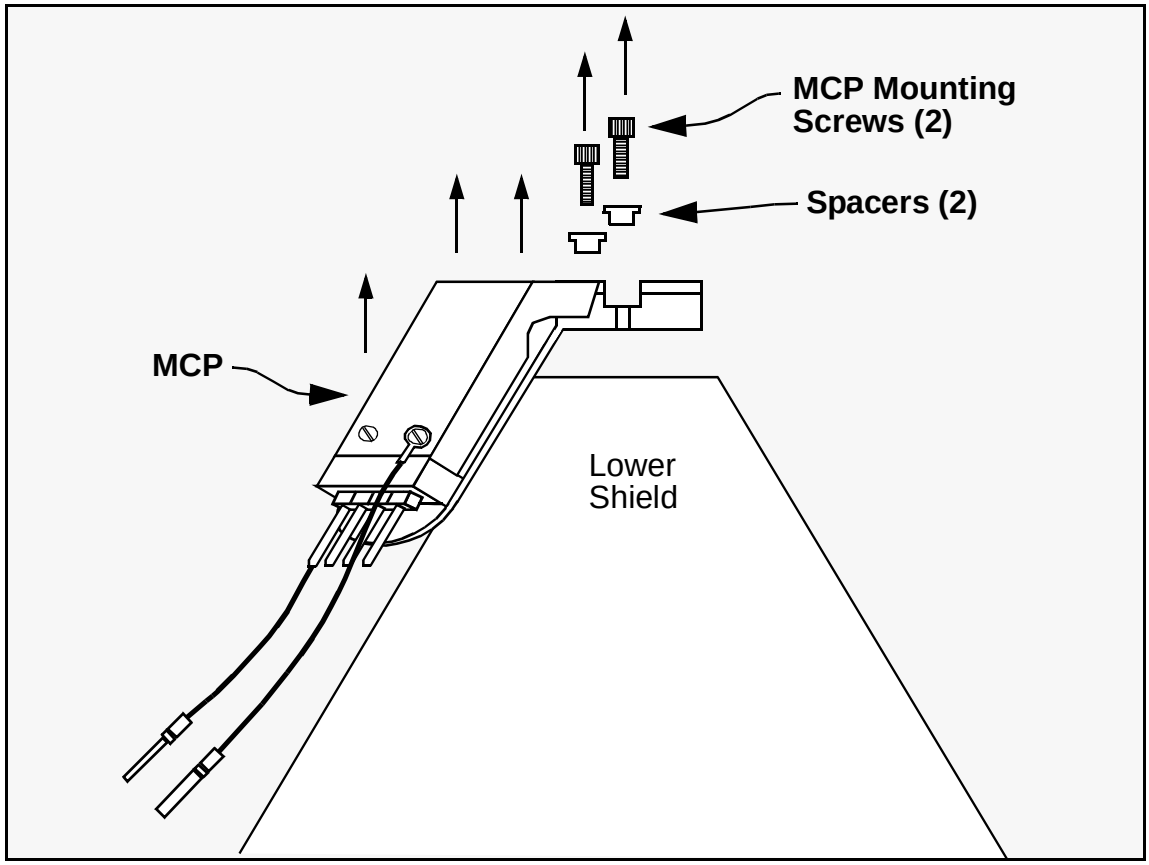


Figure 1. Removing a Small MCP

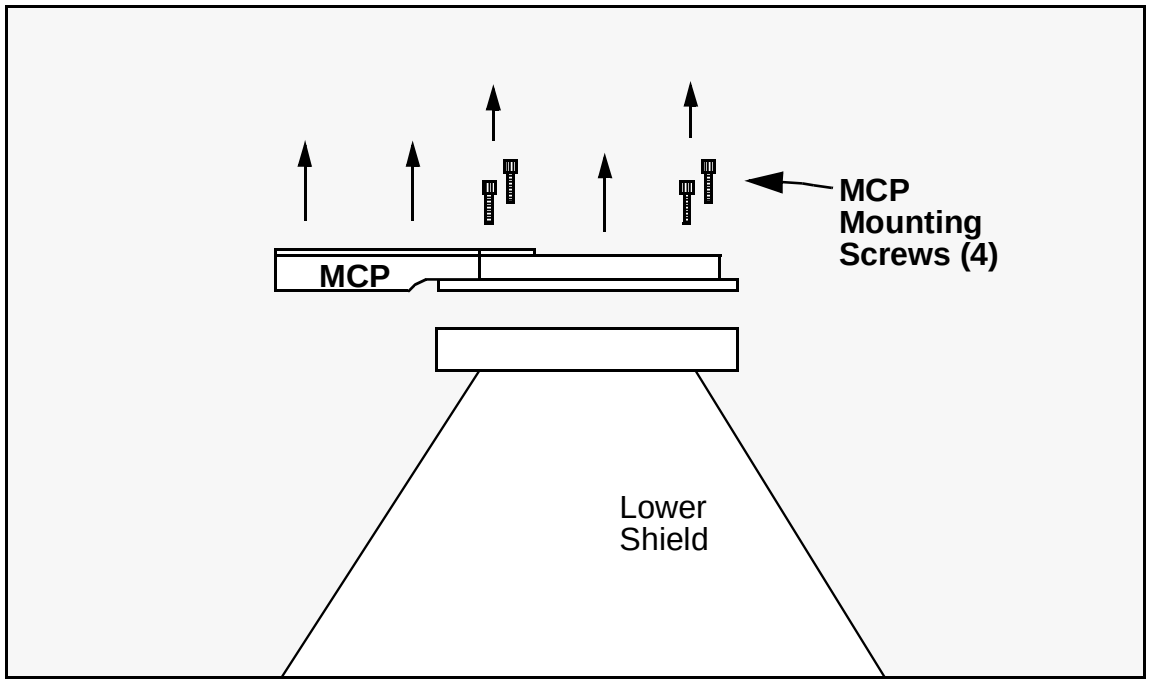


Figure 2. Removing a Large MCP

Note the rotational position of the lower shield. **The lower shield must be reinstalled in its original position for proper MCP alignment**. Remove the lower shield by loosening the three Phillips-head screws (see Figure 3).

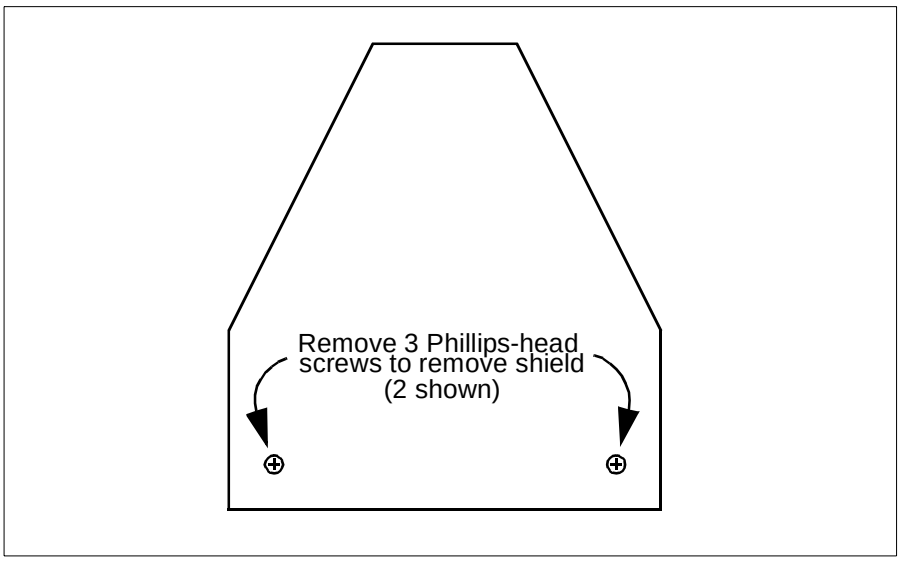


Figure 3. Side and Bottom Views of Lower Shield with Mounting Screws

Part 3. Remove the Lower Column Electrical Connectors

3-1. Pull the lower column electrical connectors out of the slot in the back of the lower column; there are eight pin/socket connections. The wires are color-coded. See Figure 4.

3-2. Loosen the hex head screw on the HV spacer and remove the high voltage wire from the HV spacer (See Figures 4 and 5). Cut off the kinked end of the high voltage wire (see Figure 5).

NOTICE: LOWER COLUMN ELEMENTS ARE FRAGILE

Handle the lower column and its elements with great care. Any scratches will ruin the lower column (Lens 2) elements. Also, any metal tracks left on ceramic surfaces cause serious problems with the column operation.

3-3. Disconnect the eight lower column electrical connectors. See Figure 5.

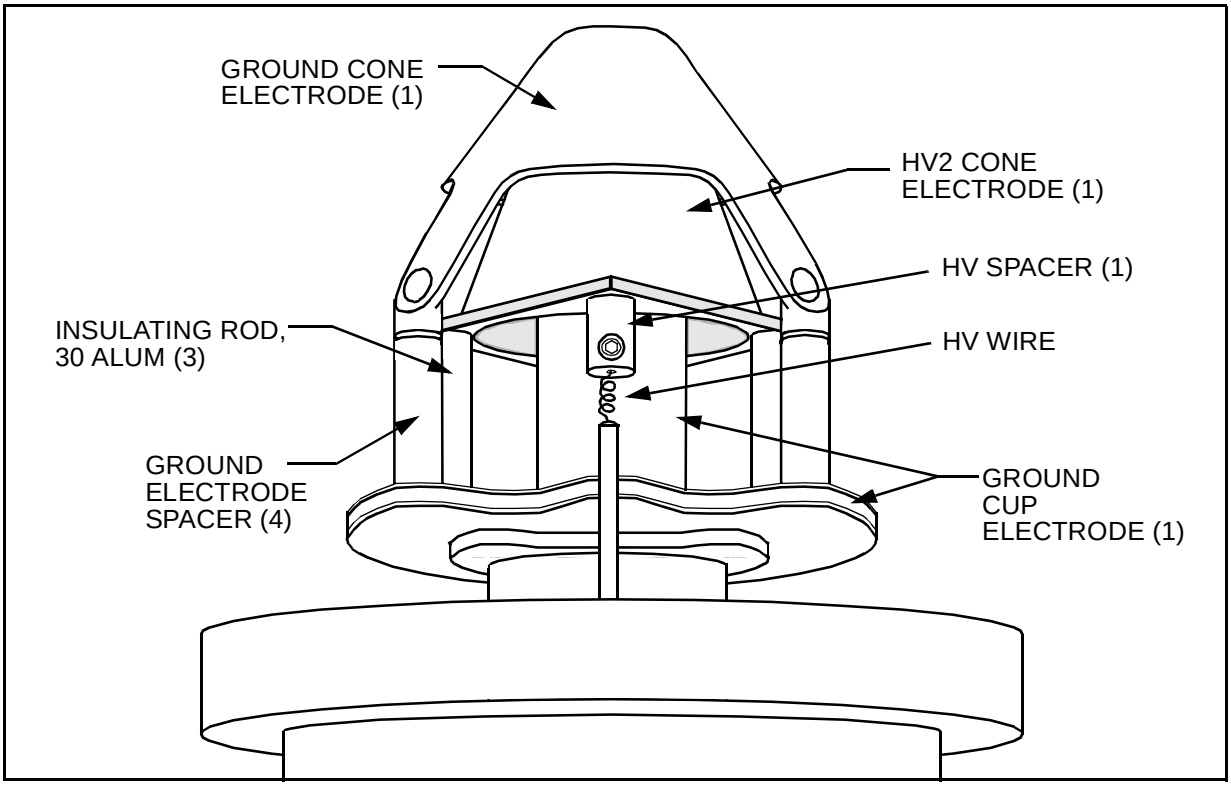


Figure 4. Lower Column (Lens 2) Without Shield

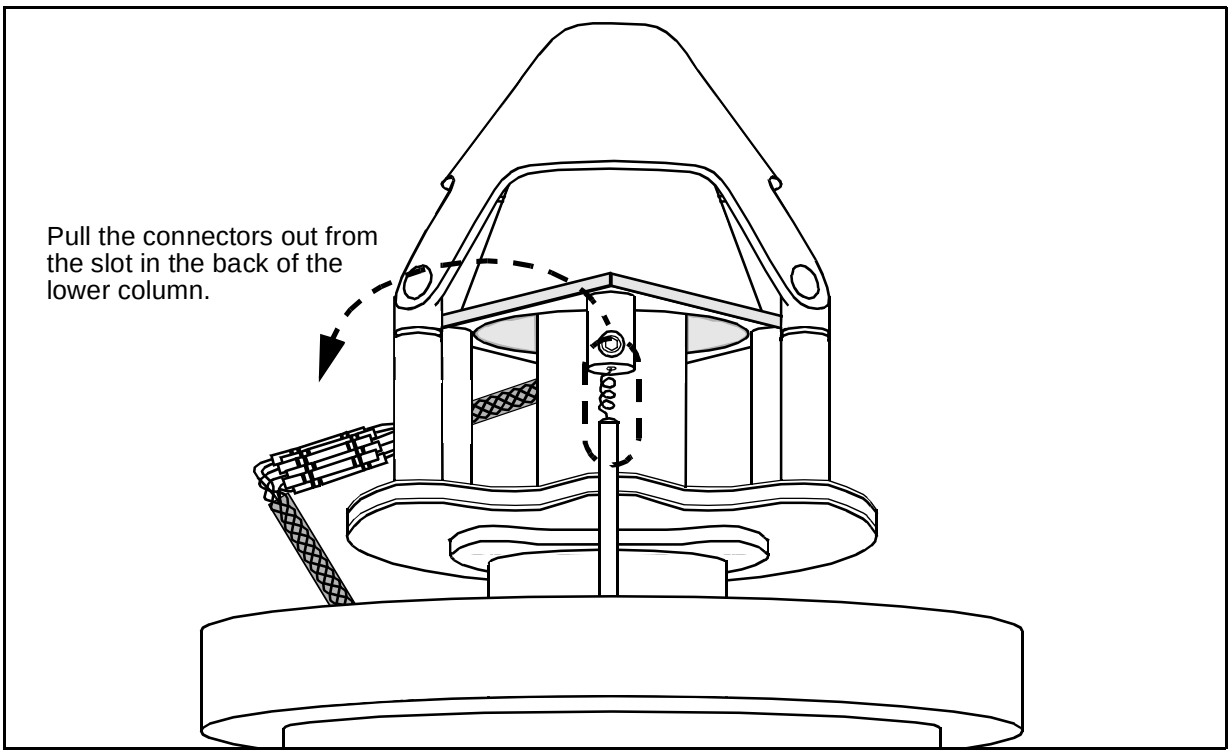


Figure 5. Lower Column Electrical Connectors

Part 4. Remove the Lower Column (Lens 2) Assembly

4-1. Remove the three screws at the base of the lower column (Lens 2) assembly (see Fig. 5).

4-2. Carefully lift the lower column (Lens 2) assembly straight up and out of the column to expose the end of the beam blanking assembly. Place it on a clean work surface.

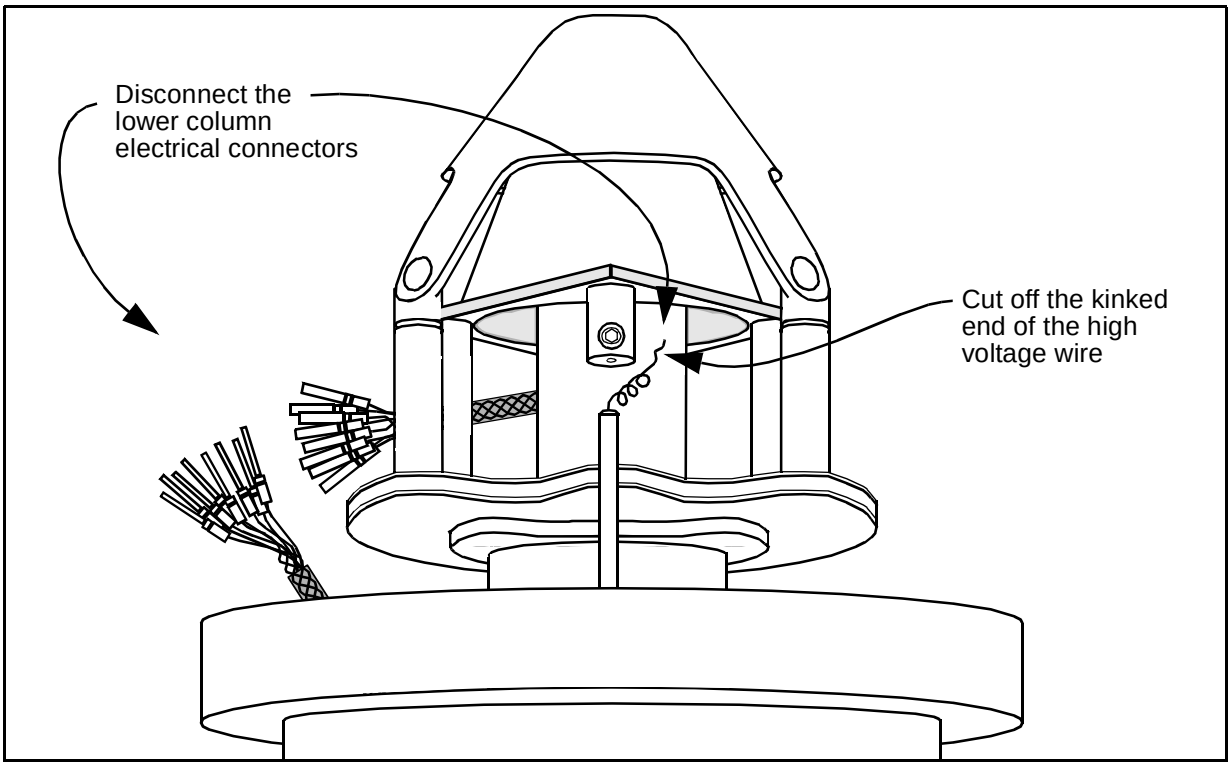


Figure 6. Disconnect the Lower Column Electrical Connectors

Part 5. Replace the Blanking Aperture

5-1. Use cotton applicators and acetone to remove the silver paint on the outside diameter of the blanking aperture (see Figure 7).

5-2. Insert a probe into the center bore of the blanking aperture and gently pry the blanking aperture loose.

NOTICE: DO NOT CONTAMINATE THE COLUMN

When removing the silver paint from the area of the blanking aperture, do not contaminate the column with silver paint particles, acetone/silver paint residue, or other contaminants.

5-3. Use cotton applicators and acetone to clean any silver paint residue from the end of the beam blanking assembly. Do not allow particles to fall into the blanking assembly.

5-4. Place the new blanking aperture in the shallow (0.004” deep) counterbore on the end of the beam blanking assembly. The blanking aperture must be seated in the counterbore to ensure proper alignment and column operation.

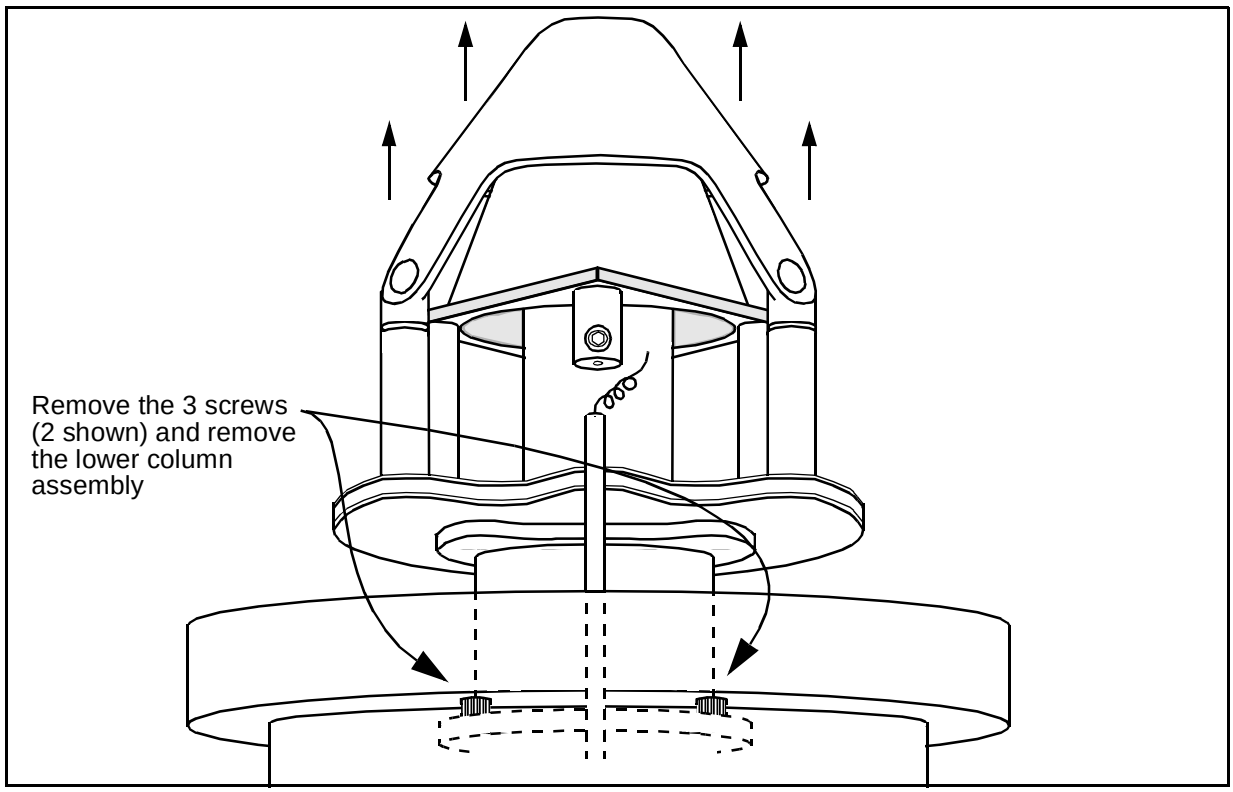


Figure 7. Remove the Lower Lens (L2) Assembly

5-5. Shake the silver paint to mix it thoroughly.

NOTICE: DO NOT CONTAMINATE THE COLUMN

When applying silver paint to the outside diameter of the blanking aperture, do not contaminate the column with silver paint. Use cotton applicators and acetone to remove any spilled paint.

5-6. Use a sharp wooden pick to apply a few beads of silver paint first on four or five spots around the outside diameter of the blanking aperture. Let the paint dry for approximately 15 minutes. Check that the aperture is still in the counterbore; if it slips out, you will not be able to align the column. Then apply apply a thin bead of paint around the outside diameter and allow to dry.

5-7. Reinstall the lower column (Lens 2) assembly (see figure 6).

5-8. Insert the high voltage wire into the hole in the HV spacer and tighten the hex head screw on the HV spacer (see Figures 3, 4, and 5).

5-9. Reconnect the lower column electrical connectors (the wires are color-coded). Tuck the

connectors and wires back into the slot in the back of the lower column (see Figure 4).

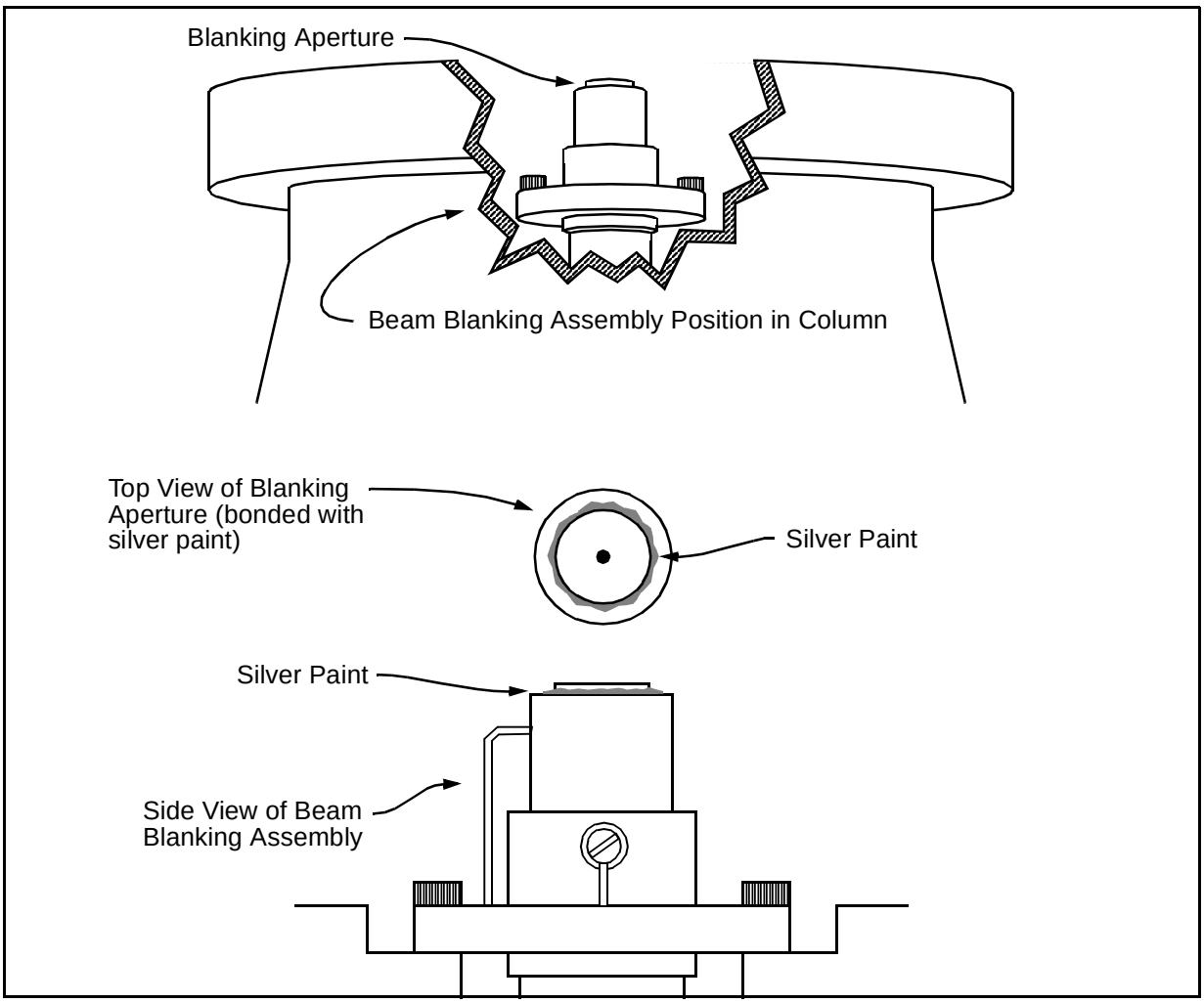

Blanking Aperture
Beam Blanking Assembly Position in Column
Top View of Blanking Aperture (bonded with silver paint)
Silver Paint
Silver Paint
Side View of Beam Blanking Assembly

Figure 8. Blanking Aperture Location

Part 6. Clean the Lower Column

6-1. Examine the lower column for contaminants under high intensity light. Figure 3 shows the lower column elements.

Use the lens brush, cotton tipped applicators, and nitrogen to gently clean off any contaminants you find; use the nitrogen to remove contaminants from areas that you are not able to reach with the brush or cotton tipped applicators. Ground element surfaces are especially susceptible to particulate contaminants.

6-2. Clean the interior of the lower shield, the gun, and the column.

NOTICE: LOWER COLUMN ELEMENTS ARE FRAGILE

Any scratches will ruin the lower column (Lens 2) elements. Also, any metal tracks left on ceramic surfaces cause serious problems with the column operation.

Part 7. Reassemble and Reinstall the Column

7-1. Reinstall the lower shield and MCP **in their original rotational positions**. The center bores of the lower shield and the Lens 2 assembly should be concentric (centrally aligned).

7-2. Clean the workchamber (as described in Service Procedure 06-03) and the ion pump connector tube.

7-3. Reinstall the column as described in Part 5 of Service Procedure 05-09-10, Column Removal and Replacement: 10 nm Column.

Micrion

Service Procedure No.: **05-16-25**
Service Procedure Title: **Blanking Aperture Replacement: 25 nm Column**
Applicable Systems: **8000, Micrion 9800 FlipChip**
Frequency of Service: **As Needed**

Introduction

During normal operation, the blanking aperture is sputtered by the ion beam. Over time, the beam will erode the blanking aperture. This procedure describes the process of removing and replacing the blanking aperture in a FIB system.

Required Materials

This procedure requires the following materials:

- Clean room, preferably with a class 100 airflow hood
- Clean, standard field service tools (completely free of oil and grease)
- Lint-free wipes
- Clean-room gloves
- High intensity light source
- Aluminum foil
- Clean lens brush
- Clean, filtered dry nitrogen (an ionizing N_2 gun is preferred) with sufficient pressure to blow off particles
- Cotton-tipped applicators
- Acetone
- Silver paint

NOTICE

Per paragraph 11.1 of *Safety Guidelines for Semiconductor Manufacturing Equipment* (S2-93), this procedure is a Type 3 task: “Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are less than 30 volts RMS, 42.2 volts peak, 240 volt-amps, and 20 Joules.”

NOTICE: TRAINING IS REQUIRED FOR THIS PROCEDURE

Do not attempt to perform this procedure unless you have been properly trained. Only qualified personnel should perform this procedure.

Part1. System Preparation

Configure the Chemical Sources in "Safe" Mode

Before performing the tasks described in this procedure, you must put the chemical sources in a "safe" mode; see Service Procedure 02-01.

WARNING

Do not proceed until the chemical sources are secure. The chemical reservoirs in FIB systems contain hazardous materials. Labels affixed to the exterior of a chemical cabinet identify the chemical(s) contained inside. If a chemical source is not in its "safest" state, as described in **Service Procedure 02-01**, it is possible for a combination of component failures to release the chemical(s) through a cabinet's delivery line, a roughing line, a purging line, or from a chemical reservoir into the workchamber. Do not open the workchamber, or disassemble any part of the vacuum pumping system, or detach any gas line from any chemical cabinet until you are sure that every chemical source attached to the FIB system is in its "safest" state.

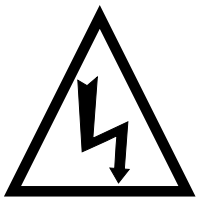
NOTICE: CLEAN THE SURROUNDING AREA

Before you vent the system, clean the exterior of the process module and the surrounding area. The column is very sensitive to contamination.

Power Down and Vent the System

Before performing the tasks described in this procedure, you must power down and vent the system; see Service Procedure 01-02.

WARNING



Dangerously high voltages are present in the process module while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and automatic procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

Part 2. Remove the Column

2-1. Remove the column as described in Parts 1, 2, 3, and 4 of Service Procedure 05-09-25, Column Removal and Replacement: 25 nm Column. Bring the column to the clean room. Cover any openings in the workchamber with aluminum foil.

CAUTION

Use care when lifting and moving the column cap and column housing assemblies. The column cap assembly weighs approximately 25 pounds (11 kg). The column housing weighs approximately 50 pounds (28 kg). If necessary to avoid personal injury, secure the help of another person.

2-2. Place the column assembly upside down on the work surface.

2-3. Remove the MCP from the lower shield (which is now facing up) by removing the four socket head mounting screws (see Figure 1). Be careful not to damage the MCP screen. Place the MCP on a clean work surface.

2-4. Remove the MCP from the bottom of the column by removing the four socket head mounting screws (see Figures 1, 2, 3, and 4). Be careful not to damage the MCP screen. Close the workchamber door.

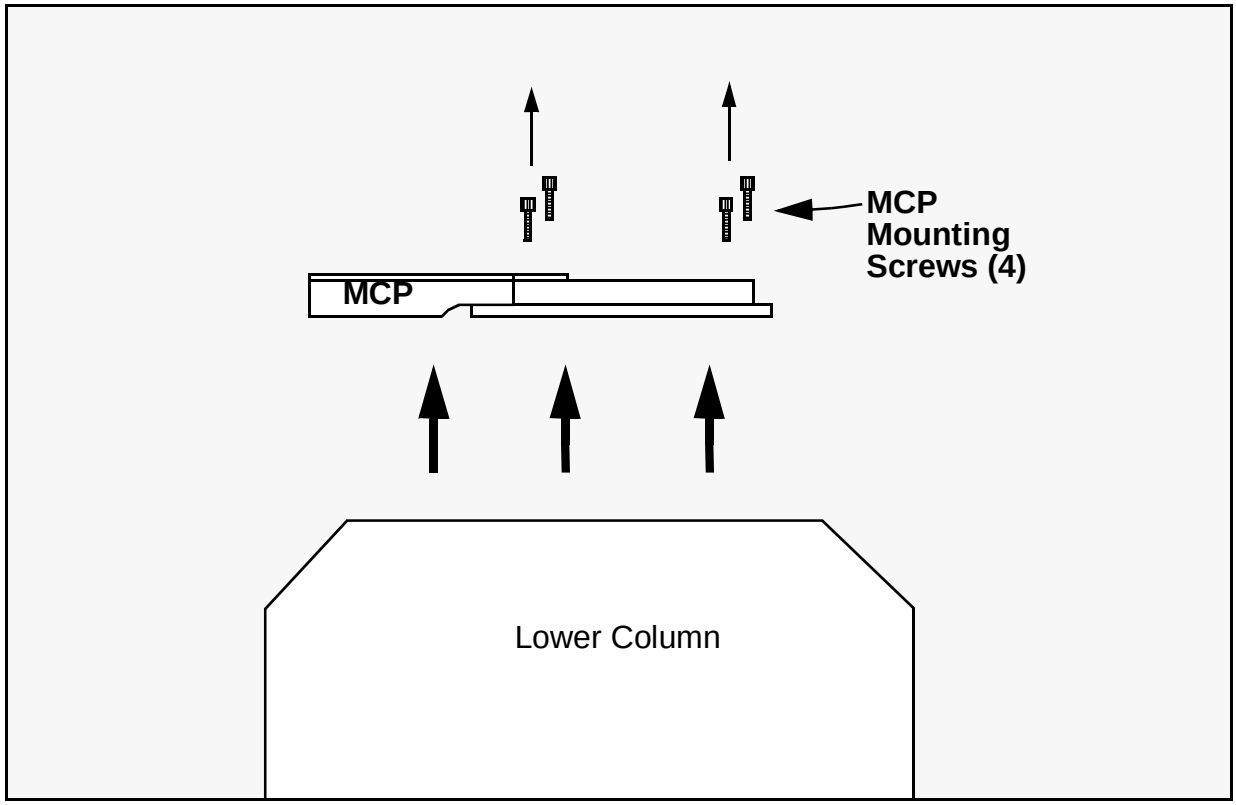


Figure 1. Flood Gun Lowered and MCP Disconnected: Side View

2-5. Note the rotational position of the lower shield. **The lower shield must be reinstalled in its original position for proper MCP alignment**. Remove the lower shield by loosening the three Phillips-head screws (see Figure 2).

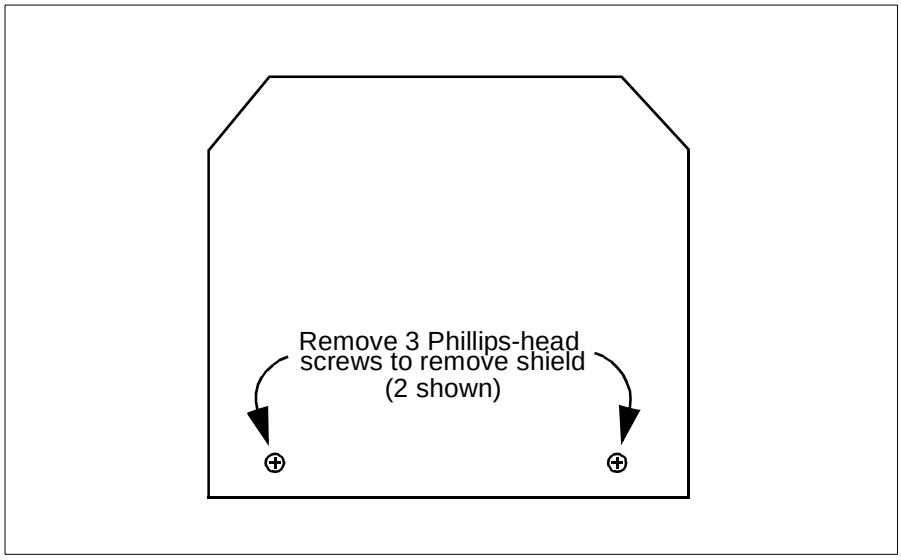


Figure 2. Side and Bottom Views of Lower Shield with Mounting Screws

WEAR GLOVES, DO NOT HANDLE SOLVENTS

When working inside the chamber or when handling any components that will be exposed to vacuum, wear gloves rated for Class 100 environments or better. Due to disintegration of such gloves by solvents, do not handle solvents or parts that are wet with solvent.

NOTICE: LOWER COLUMN ELEMENTS ARE FRAGILE

Handle the lower column and its elements with great care. Any scratches will ruin the lower column (Lens 2) elements. Also, any metal tracks left on ceramic surfaces cause serious problems with the column operation.

Part 3. Loosen the L2 HV (High Voltage) Cap Screws

Loosen the L2 high voltage cap until there is enough play to remove the high voltage feed tube. See Figure 3.

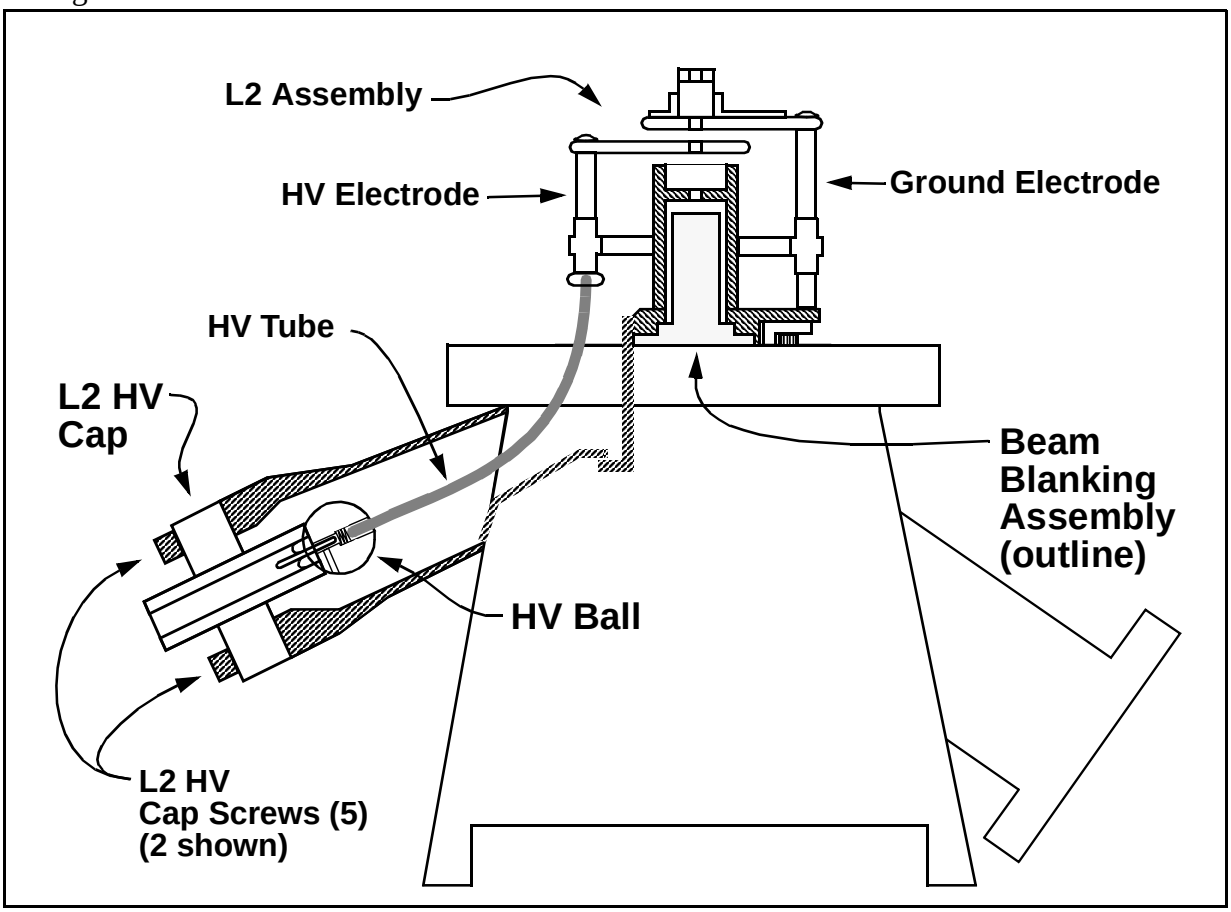


Figure 3. Side (Cross-sectional) View of Column on Bench with Lower Shield Removed

Part 4. Remove the L2 High Voltage Feed Tube

Remove the L2 high voltage feed tube. See Figures 4, 5, and 6.

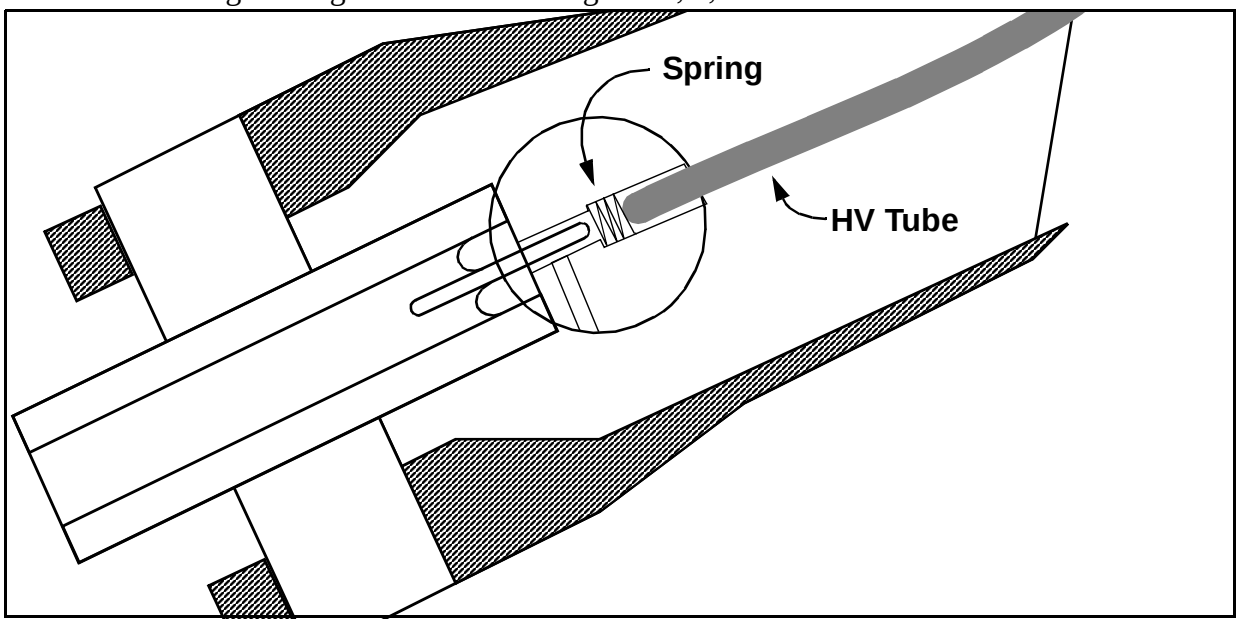


Figure 4. Detail of HV Ball and HV Tube

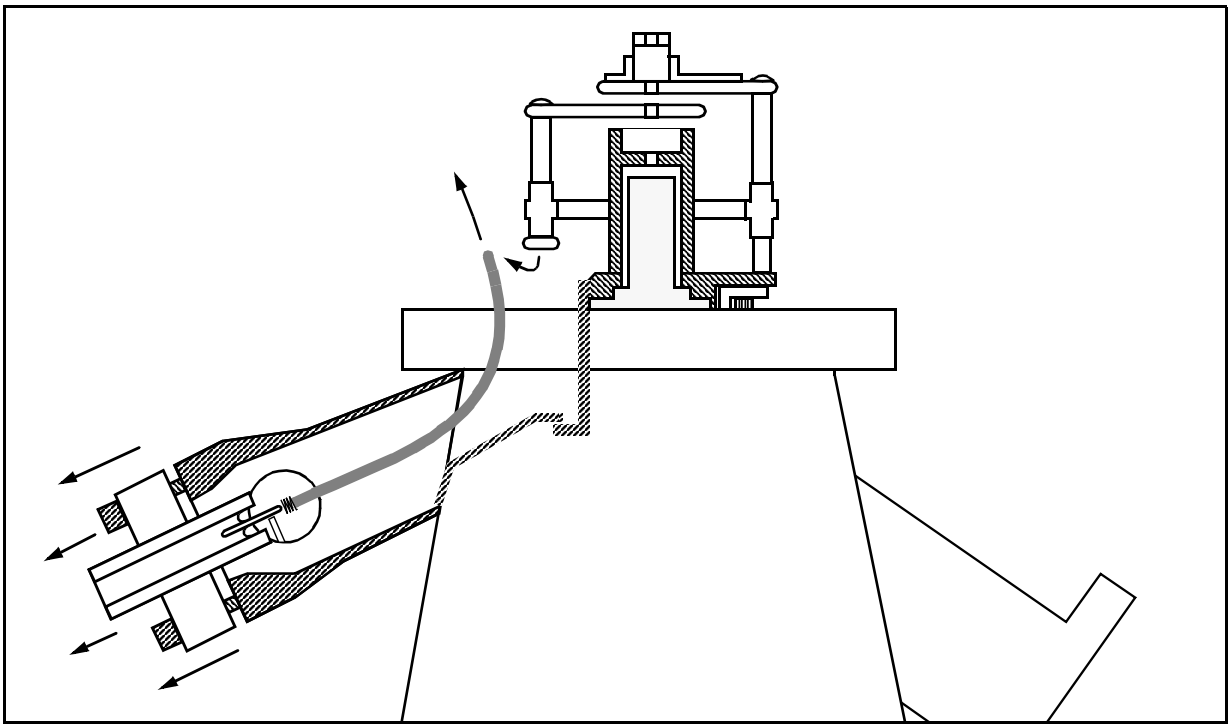


Figure 5. HV Cap Screw Loosened, L2 End of HV Tube Removed from L2 Electrode

4-1. Clean the L2 high voltage feed tube and place it on a clean work surface.

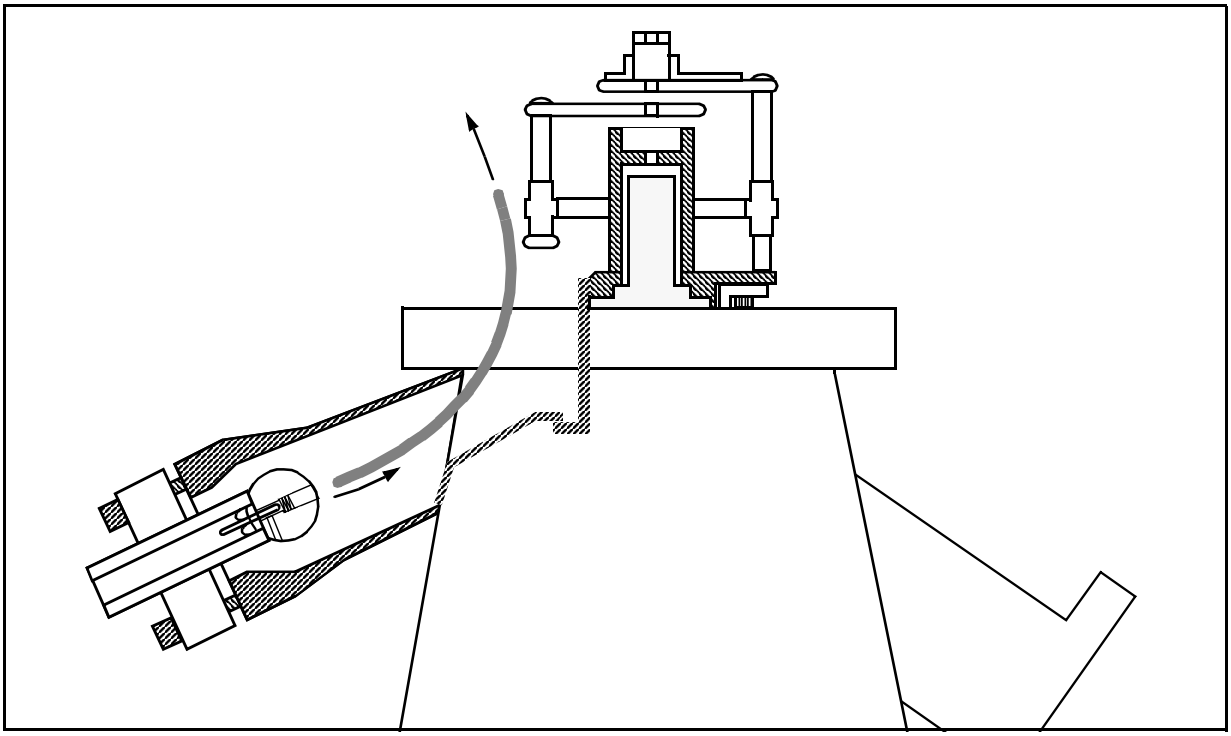


Figure 6. Removal of HV Tube

Part 5. Remove the Lower Column (Lens 2) Assembly

NOTICE: DO NOT DAMAGE THE L2 WIRES

Do not strain the L2 wires when removing the L2 assembly; provide adequate strain relief so that the wires are not damaged.

5-1. Use a bent allen wrench to remove the three screws at the base of the lower column (Lens 2) assembly (see Figure 7). Recover any dropped screws before proceeding.

5-2. Carefully lift the Lens 2 (L2) assembly out of the column to expose the end of the beam blanking assembly (see Figure 8).

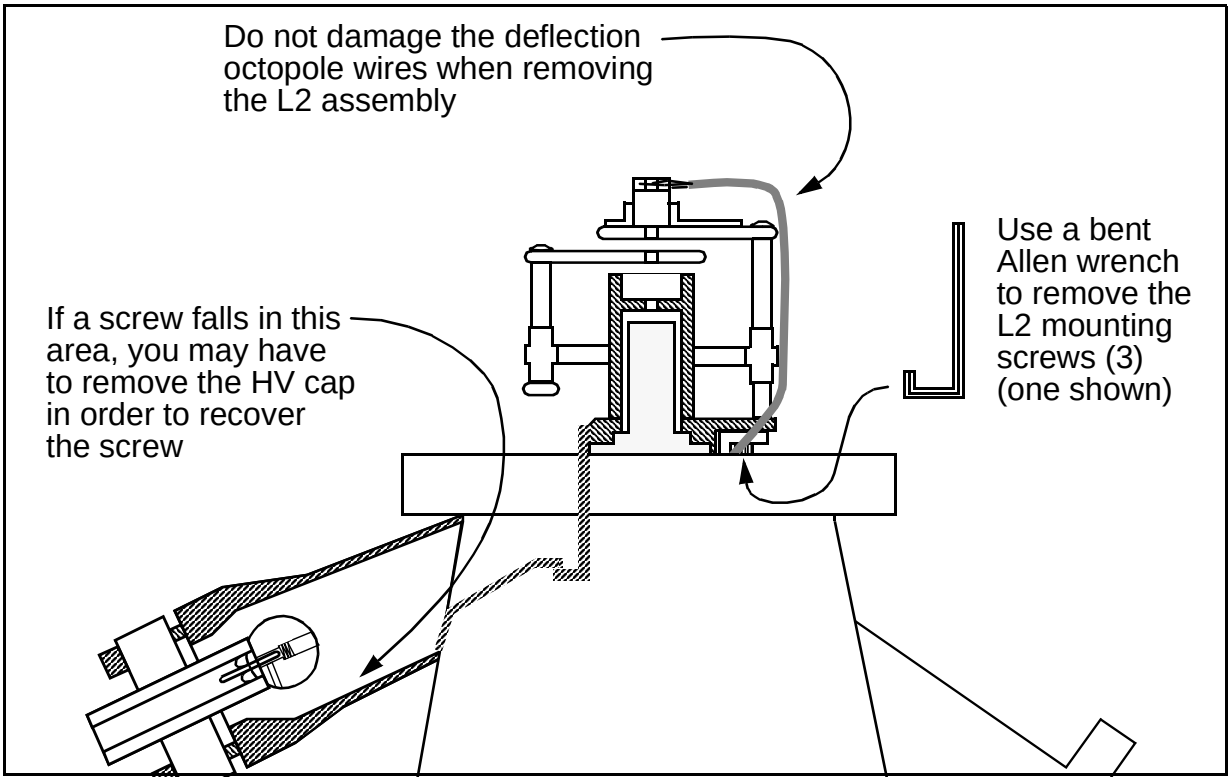

Do not damage the deflection octopole wires when removing the L2 assembly
Use a bent Allen wrench to remove the L2 mounting screws (3) (one shown)
If a screw falls in this area, you may have to remove the HV cap in order to recover the screw

Figure 7. Removal of L2 Assembly Mounting Screws

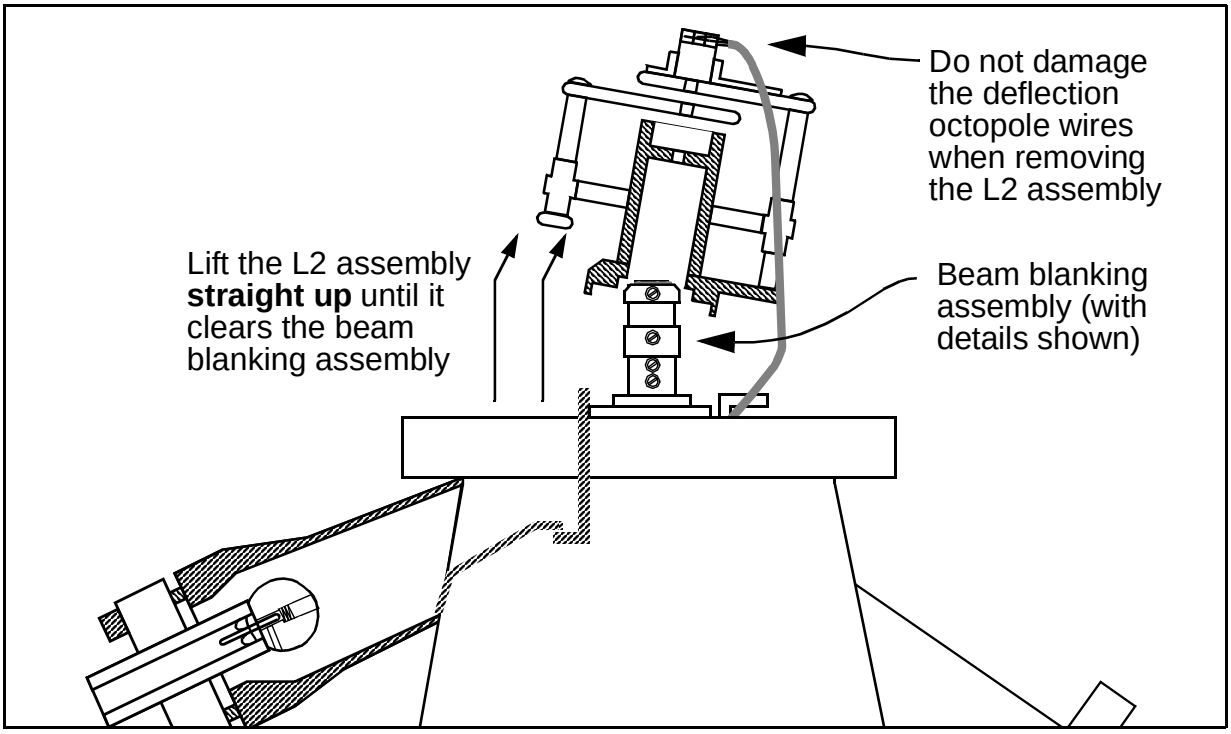

Do not damage the deflection octopole wires when removing the L2 assembly
Lift the L2 assembly **straight up** until it clears the beam blanking assembly
Beam blanking assembly (with details shown)

Figure 8. Removal of L2 Assembly

5-3. To avoid damaging the beam blanking assembly, lift the L2 assembly straight up until it clears the beam blanking assembly. Carefully balance the assembly on the lower column flange: place a clean wipe under the assembly to avoid scratching the L2 and flange surfaces (see Figure 9). Make sure that the wires are not strained; if necessary, use tie wraps or some other means to secure the L2 assembly so that the wires are not damaged.

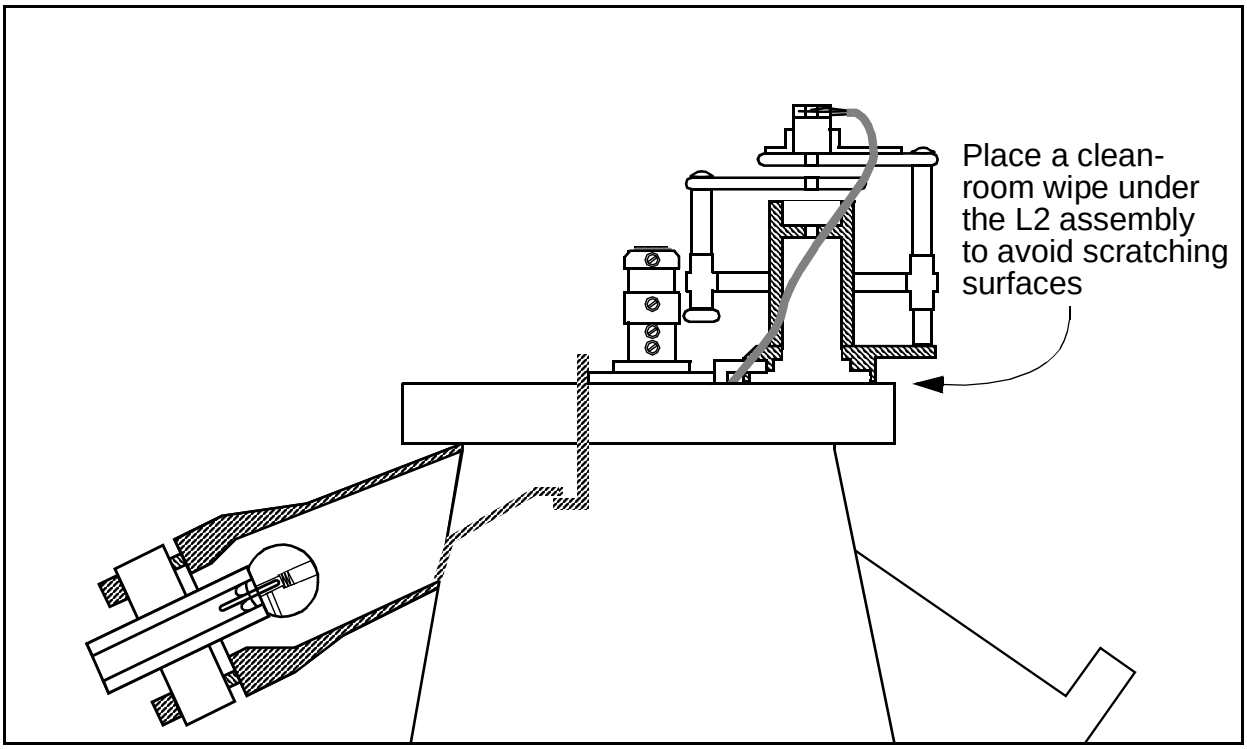


Figure 9. L2 Assembly Removed and Placed on Column

Part 6. Replace the Blanking Aperture

6-1. Use cotton applicators and acetone to remove the silver paint on the outside diameter of the blanking aperture (see Figure 10).

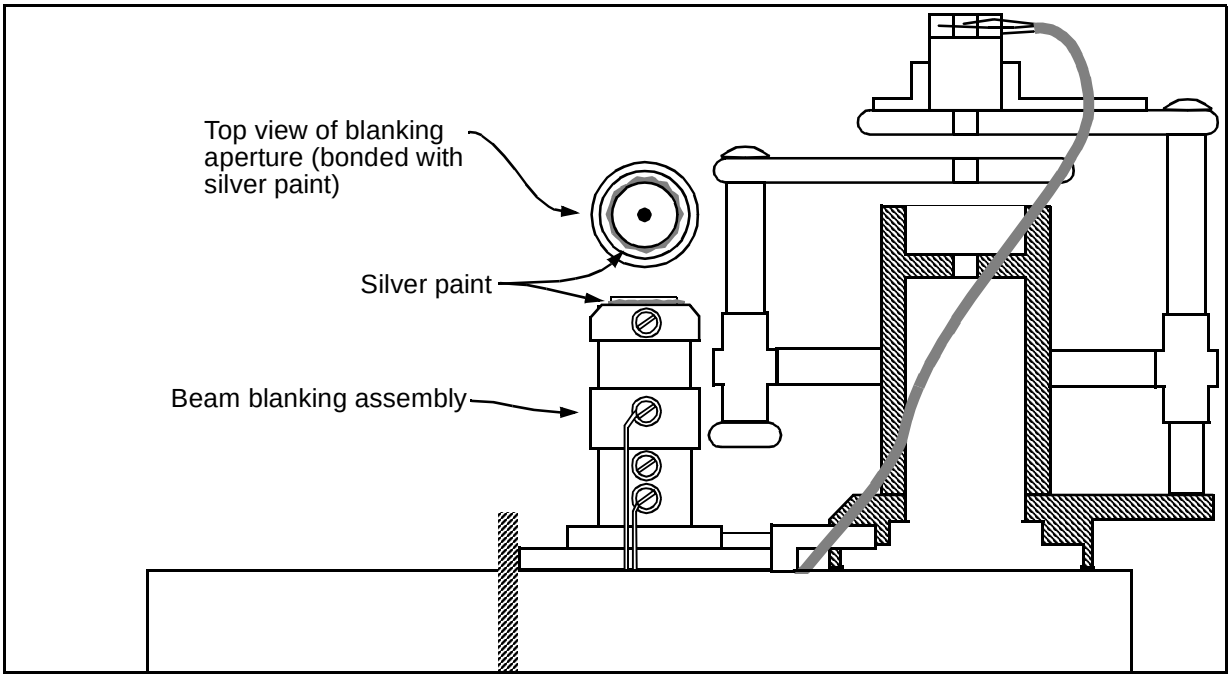


Figure 10. Side and Top Views of Beam Blanking Aperture

6-2. Insert a probe into the center bore of the blanking aperture and gently pry the blanking aperture loose.

NOTICE: DO NOT CONTAMINATE THE COLUMN

When removing the silver paint from the area of the blanking aperture, do not contaminate the column with silver paint particles, acetone/silver paint residue, or other contaminants.

6-3. Use cotton applicators and acetone to clean any remaining silver paint residue from the end of the beam blanking assembly.

6-4. Place the new blanking aperture in the shallow (0.004” deep) counterbore on the end of the beam blanking assembly. The blanking aperture must be seated in the counterbore to ensure proper alignment.

6-5. Shake the silver paint to mix it thoroughly.

NOTICE: DO NOT CONTAMINATE THE COLUMN

When applying silver paint to the outside diameter of the blanking aperture, do not contaminate the column with silver paint. Use cotton applicators and acetone to remove any spilled paint.

6-6. Use a sharp wooden pick to apply a thin bead of silver paint around the outside diameter of the blanking aperture (see Figure 10). Let the paint dry for approximately 15 minutes.

6-7. Reinstall the lower column (Lens 2) assembly.

Part 7. Clean the Lower Column

7-1. Examine the lower column for contaminants under high intensity light. Figure 3 shows the lower column elements.

Use the lens brush, cotton tipped applicators, and nitrogen to gently clean off any contaminants you find; use the nitrogen to remove contaminants from areas that you are not able to reach with the brush or cotton tipped applicators. Ground element surfaces are especially susceptible to particulate contaminants.

7-2. Clean the interior of the lower shield.

NOTICE: LOWER COLUMN ELEMENTS ARE FRAGILE

Any scratches will ruin the lower column (Lens 2) elements. Also, any metal tracks left on ceramic surfaces cause serious problems with the column operation.

Part 8. Reassemble and Reinstall the Column

8-1. Reinstall the lower shield and MCP **in their original rotational positions**. The center bores of the lower shield and the Lens 2 assembly should be concentric (centrally aligned).

8-2. Clean the workchamber (as described in Service Procedure 06-03) and the ion pump connector tube.

8-3. Reinstall the column as described in Part 5 of Service Procedure 05-09-25, Column Removal and Replacement: 25 nm Column.

Section 6: Loadlock, Workchamber

- 06-01 Sample Holder Inspection and Cleaning
- 06-02 Loadlock Inspection and Cleaning
- 06-03 Workchamber Inspection and Cleaning
- 06-04 Transport Carriage Inspection and Alignment

Micrion

Service Procedure No.: 06-01
Service Procedure Title: Sample Holder Inspection and Cleaning
Applicable Systems: 8000, Micrion 9800 FlipChip, MicroMill HT
Frequency of Service: Monthly

Introduction

The FIB system is equipped with sample holders (mask or wafer holders, or head array carriers) that carry the sample into workchamber. These holders require monthly cleaning and inspection for mechanical damage.

The holders should be stored in a cabinet or container that protects them from mechanical shock, contamination, and moisture. A desiccating cabinet with a constant flow of dry nitrogen is ideal.

Materials Required

This procedure requires the following materials:

- Clean-room gloves
- Laboratory grade isopropyl alcohol
- Lint-free wipes
- Dry nitrogen hose/gun

In addition, the following is recommended:

- High intensity lamp

This procedure refers to Service Procedure 06-04, Transport Carriage Inspection.

NOTICE

Follow the cleaning and de-greasing procedures specified for your clean room. The procedure that follows here calls for isopropyl alcohol. This may NOT be appropriate for your clean room.

Part 1. Inspection Procedure

1-1. Clear a work surface of any objects that might damage the holder(s).

1-2. Normally the holders are stored in a desiccating cabinet when not in use. Wear gloves when removing a sample holder from the FIB transport carriage. Place the sample holder on the work surface.

NOTICE: WEAR GLOVES, DO NOT HANDLE SOLVENTS

When working inside the chamber or when handling any components that will be exposed to vacuum, wear gloves rated for Class 100 environments or better. Due to disintegration of such gloves by solvents, do not handle solvents or parts that are wet with solvents.

1-3. Inspect the sample holders one at a time for nicks or scratches in the nickel plating.

The nickel plating is between 0.2 mils (0.0002") and 0.5 mils (0.0005") thick. Deep scratches or nicks that expose the underlying metal may allow outgassing that degrades the sample holder's vacuum characteristics. If you find such defects, and pumpdown times for the load sequence are noticeably longer than normal, contact Micrion Product Support for advice.

NOTICE

If users are contaminating the sample holders, please bring it to their attention.

Part 2. Cleaning Procedure

2-1. Remove the gloves; handle the sample holder with lint-free wipes (See Figure 1).

2-2. Wipe the sample holder with a lint-free wipe dipped in isopropyl alcohol. Avoid getting cloth fibers caught on the corners of the sample holder. When the entire sample holder has been wiped, blow it dry with nitrogen.

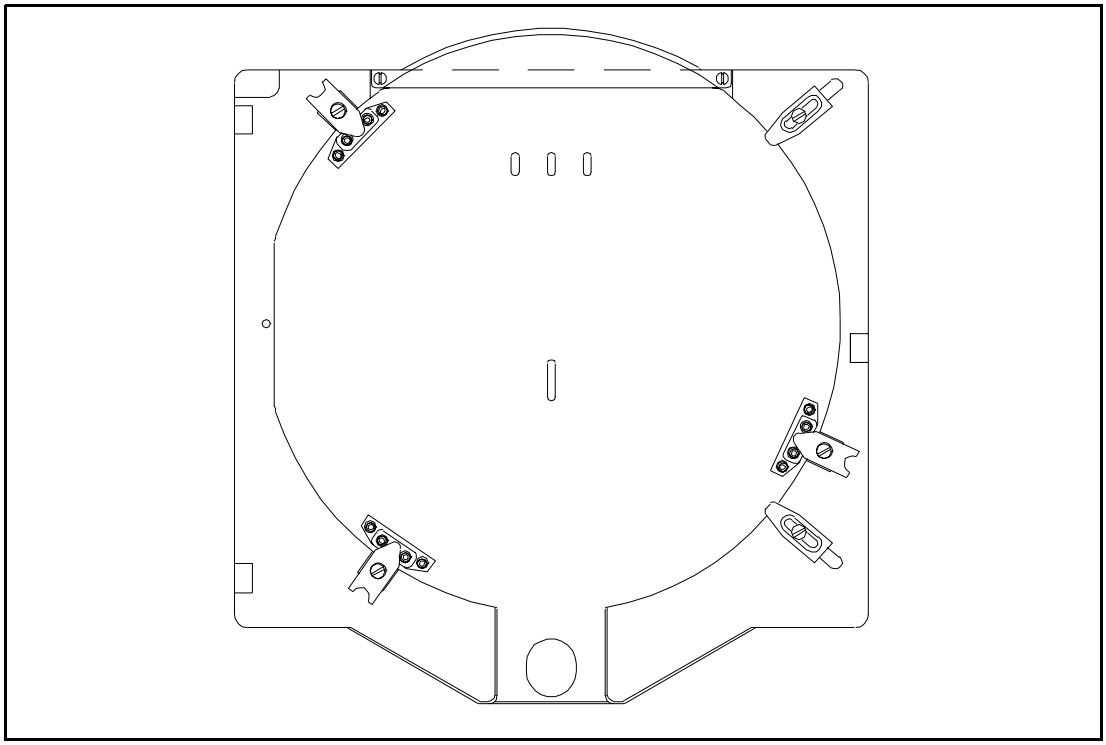


Figure 1. Sample Holder: 8000 Series

2-3. Thoroughly clean the top and bottom surfaces of the sample holder with isopropyl alcohol, and blow these surfaces dry with nitrogen.

2-4. Put on clean-room gloves and examine the results of the cleaning. If possible, inspect the sample holder under ultraviolet light in a slightly darkened room, and then repeat this inspection under high intensity white light. The light sources illuminate particulates not visible in ambient light. Rotate each sample holder to view its entire surface. Use the nitrogen jet to remove any foreign matter. If necessary, repeat the cleaning procedure (steps 2-1 through 2-3).

Note: no lubrication is necessary.

2-5. Return the sample holder to its storage cabinet.

Micrion

Service Procedure No.: **06-02**
Service Procedure Title: **Loadlock Inspection and Cleaning**
Applicable Systems: **All**
Frequency of Service: **Monthly, or prior to venting the system**

Introduction

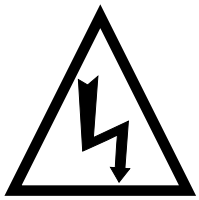
Because of exposure to air-borne contamination during use, the loadlock vacuum seal may deteriorate and develop leaks, causing extended pumpdown time; it is also a route of entry for contamination into the system and column. This procedure describes how to inspect and clean the loadlock and the loadlock vacuum seal.

Materials Required

This procedure requires the use of the following materials:

- Clean-room vacuum cleaner
- Low-lint wipes
- Laboratory-grade isopropyl alcohol
- Braycote 803 vacuum grease (Micrion part no. 790-000006) or equivalent
- Clean-room gloves
- High-intensity light
- High-pressure N_2 blowgun with 30 psi pressure or more

WARNING



Dangerously high voltage is present in the process module while the FIB system is powered up. All high voltage wiring is heavily insulated and connections are interlocked. However, any such safeguards can fail. Therefore, do not touch any of the wiring in the process module while the FIB system is powered-up**.**

Part 1. Gaining Access to the Loadlock

1-1. To inspect the loadlock without venting the system, follow one of these steps:

•Using the *Load/Unload* icon in the application program, unload the carrier from the workchamber. This not only retrieves the carrier and transport carriage, but also vents the loadlock. Remove the carrier from the transport mechanism to continue with the procedure.

•Using the *Vacchat* program, vent the loadlock manually while leaving the specimen-holder in the workchamber under vacuum, with the following commands:

`clv6`↵	Close the gate valve to the loadlock.
`clv1`↵	Close the valve to the rough pump.
`clv2`↵	Close the bleed valve to the workchamber.
`opv5`↵	Open the nitrogen supply valve.
`opv3`↵	Allow the loadlock to vent.

1-2. When the loadlock is vented, open the loadlock door. When the loadlock is vented, close V5 with the *vacchat* command, `clv5`, then open the loadlock door.

NOTICE: WEAR GLOVES, DO NOT HANDLE SOLVENTS

When working inside the chamber or when handling any components that will be exposed to vacuum, wear gloves rated for Class 100 environments or better. Due to disintegration of such gloves by solvents, do not handle solvents or parts that are wet with solvent.

Part 2. Inspecting and Cleaning the Loadlock

2-1. Using a high-intensity light, inspect the loadlock inside and out for particulate contamination. To see particles clearly, shine the light over the surfaces at a low angle.

2-2. Use the vacuum cleaner and N_2 blowgun to remove debris from interior and exterior areas surrounding the loadlock. Do not disturb the wiring inside the loadlock.

2-3. If necessary, use a clean-room wiper dampened with isopropyl alcohol to wipe the interior of the loadlock and the underside of the loadlock door.

2-4. Inspect the O-ring and the corresponding vacuum seal area of the door for scratches that could cause leaks. If the O-ring is seriously scratched or nicked, it should be replaced. If the vacuum seal area of the loadlock door is damaged, contact Micrion Product Support.

a. With *gloved hands*, open the loadlock door and carefully remove the O-ring from its groove in the loadlock housing. You can use the long narrow end of a plastic tie-wrap (but do **not** use a sharp metal object) to pry the O-ring out of its groove, but be extremely careful not to scratch or otherwise damage the O-ring, the groove, or the surrounding vacuum surface of the loadlock housing.

b. Clean the O-ring of old grease and debris by holding a clean room wiper around the O-ring with one hand and gently pulling the O-ring through the wiper.

2-5. Inspect the following cable connections underneath the loadlock:

- Transport motor 10-pin ribbon cable connector
- Pressure sense switch 2-pin cable connector
- P-Trans switch BNC connectors (2)

2-6. Lubricate the O-ring with the Braycote 803 vacuum grease as follows:

a. Place a small bead of the grease on the tips of your gloved index finger and thumb.

b. Gently rub those two fingers together to obtain a uniform coating.

c. Pull the O-ring through the fingers to apply a uniformly thin coating of grease.

d. Carefully inspect both the O-ring and the O-ring groove, and remove any fibers or other debris that could cause vacuum leaks.

2-7. Beginning at the rear of the loadlock, place the O-ring in its groove and work toward the front. You can lower the loadlock door slightly to help press the O-ring into the groove at the rear, but be careful not to pinch it.

2-8. Inspect all loadlock cable connections (motor power cables, encoder ribbon cable, and BNC connectors) to make sure that they are secure.

Micron

Service Procedure No.: **06-03**
Service Procedure Title: **Workchamber Inspection and Cleaning**
Applicable Systems: **All**
Frequency of Service: **Monthly, or whenever venting the system**

Introduction

This procedure describes how to inspect and clean the interior of the workchamber.

Materials Required

- Clean-room gloves
- Lint-free wipes
- Laboratory grade isopropyl alcohol
- High-intensity light
- Clean-room vacuum cleaner
- Dry nitrogen (N_2) gun with at least 30 psi pressure

NOTICE

Per paragraph 11.1 of Safety Guidelines for Semiconductor Manufacturing Equipment (S2-93), this procedure is a Type 3 task. Specifically: "Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are less than 30 volts RMS, 42.2 volts peak, 240 volt-amps, and 20 Joules."

Part 1. System Preparation

Configure the Chemical Sources in "Safe" Mode

Before performing the tasks described in this procedure, you must put the chemical sources in a "safe" mode; see Service Procedure 02-01.

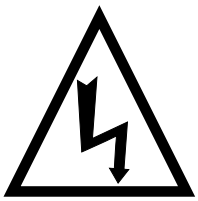
WARNING

Do not proceed until the chemical sources are secure. The chemical reservoirs in FIB systems contain hazardous materials. Labels affixed to the exterior of a chemical cabinet identify the chemical(s) contained inside. If a chemical source is not in its "safest" state, as described in Service Procedure 02-01, it is possible for a combination of component failures to release the chemical(s) through a cabinet's delivery line, a roughing line, a purging line, or from a chemical reservoir into the workchamber. Do not open the workchamber, or disassemble any part of the vacuum pumping system, or detach any gas line from any chemical cabinet until you are sure that every chemical source attached to the FIB system is in its "safest" state.

Power Down and Vent the System

Before performing the tasks described in this procedure, you must power down and vent the system; see Service Procedure 01-02.

WARNING

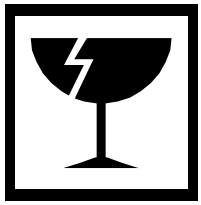


Dangerously high voltages are present in the process module while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and automatic procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

Part 2. Vacuum and Clean the Workchamber

2-1. Remove the socket-head cap screws, and open the workchamber cover or door.

NOTICE: WORKCHAMBER EQUIPMENT IS FRAGILE



With the workchamber door open, several pieces of delicate equipment are exposed. Take great care not to disturb the electron flood gun and the microchannel plate (MCP), which are located at or near the bottom of the ion beam column. Do not damage the gas delivery and deposition funnel system components located at the front of the workchamber.

2-2. Using the application software, move the stage to the Stage Zero position, which is in the right rear corner of the workchamber as you face the front of the system.

NOTICE: WEAR GLOVES, DO NOT HANDLE SOLVENTS

When working inside the chamber or when handling any components that will be exposed to vacuum, wear gloves rated for Class 100 environments or better. Due to disintegration of such gloves by solvents and the possibility of contaminating parts, do not handle solvents or parts that are wet with solvent.

2-3. Using a high-intensity light, examine the inside of the workchamber. Look for particulate contamination. To see particles clearly, shine the light over the surfaces at a low angle.

2-4. Using the clean room vacuum cleaner and the N_2 blowgun, clean the inside of the workchamber, including the walls and interior door surface. Be sure to clean out the gate valve, V6, between the loadlock and the workchamber, where dust from samples accumulates.

At completion of this task, no dust should be visible in high-intensity light.

2-5. Move the stage to the left rear corner in the workchamber and vacuum the right rear corner of the workchamber.

2-6. Using a high-intensity light, examine the inside of the workchamber. Look for particulate contamination. To see the particles easily, direct the light on the surfaces at a low angle.

2-7. Vacuum the workchamber, using the DN_2 gun to dislodge particles from areas that are inaccessible to the vacuum cleaner. Use lint-free wipes if necessary.

2-8. Use lint-free wipes to remove any surface contaminants.

2-9. Clean the stage, being careful not to move the grids, mirrors, or lead screws.

2-10. After thoroughly cleaning and vacuuming all areas of the workchamber, close the door and tighten the bolts until the workchamber door makes contact with the O-ring.

2-11. Pump down as described in Service Procedure 04-03, then tighten the door bolts.

Micrion

Service Procedure No.: **06-04**
Service Procedure Title: **Transport Carriage Inspection and Alignment**
Applicable Systems: **8000, Micrion 9800 Flip Chip, MicroMill HT**
Frequency of Service: **Every Six Months**

Introduction

An interlocking latch mechanism secures the transport carriage and the sample holder together during transportation of the sample holder in and out of the workchamber.

This procedure assumes that the drive tape is connected to the transport carriage.

Materials Required

This procedure requires the following materials and equipment:

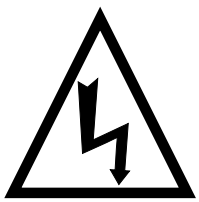
- Standard field service engineer's tool set
- Clean-room gloves
- Lint-free wipes
- Laboratory-grade isopropyl alcohol

This procedure refers to Service Procedure 06-01, Sample Holder Inspection and Cleaning.

NOTICE

Per paragraph 11.1 of Safety Guidelines for Semiconductor Manufacturing Equipment (S2-93), this procedure is a Type 3 task. Specifically: "Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are less than 30 volts RMS, 42.2 volts peak, 240 volt-amps, and 20 Joules."

WARNING



Dangerously high voltage is present in the process module while the FIB system is powered up. All high voltage wiring is heavily insulated and connections are interlocked. However, any such safeguards can fail. Do not touch any of the wiring in the process module while the FIB system is powered-up**.**

Part 1. Inspection of the Transport Carriage

1-1. If a sample holder is in the workchamber, retrieve the sample holder by selecting the *Unload* button on the Load/Unload window on the Microsurgery menu bar.

NOTICE: WEAR GLOVES, DO NOT HANDLE SOLVENTS

When working inside the chamber or when handling any components that will be exposed to vacuum, wear gloves rated for Class 100 environments or better. Due to disintegration of such gloves by solvents, do not handle solvents or parts that are wet with solvent.

1-2. Vent the loadlock to atmospheric pressure (see Service Procedure 01-02, Part 3).

1-3. Open the loadlock door, releasing the sample holder from the transport carriage.

1-4. To lift the sample holder from the transport carriage (Figure 1, A), slide the sample holder toward the rear of the loadlock and lift it clear of the alignment pins (Figure 1, B).

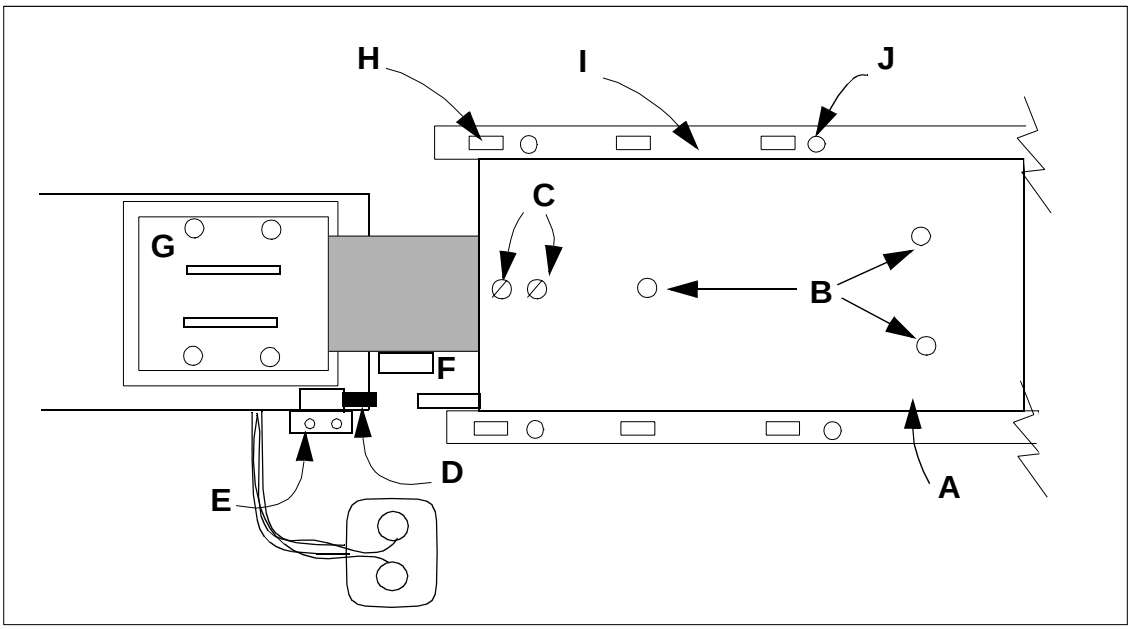


Figure 1. Transport Carriage and Transport Tape Drive: Top View

Table 1: Call outs in Transport Carriage Drawing

A	Transport carriage	F	Hard stop
B	Alignment pins	G	Transport drive
C	1-72 screws (2)	H	Roller bearing
D	Retract switch	I	Rail
E	Retract switch adjustment screws	J	3-32" socket head screw

1-5. To ensure the cleanliness of the sample holder, perform Service Procedure 06-01.

1-6. Tighten the two 1-72 screws holding the tape to the transport carriage (Figure 1, C).

1-7. Test the retract switch. With a small screwdriver or other tool, move the contact (Figure 1, D) towards the switch. After about 1/16" of movement, you will feel the switch being thrown. The retract switch cuts off the DMTS signal.

Part 2. Alignment of the Rails

2-1. Begin with the transport carriage in the loadlock (Use the *vacchat* command `re` to retract it if necessary).

2-2. Since the stage height is fixed, start the alignment from the stage and move toward the platehold guide (bridge) and then to the loadlock. See Figure 2.

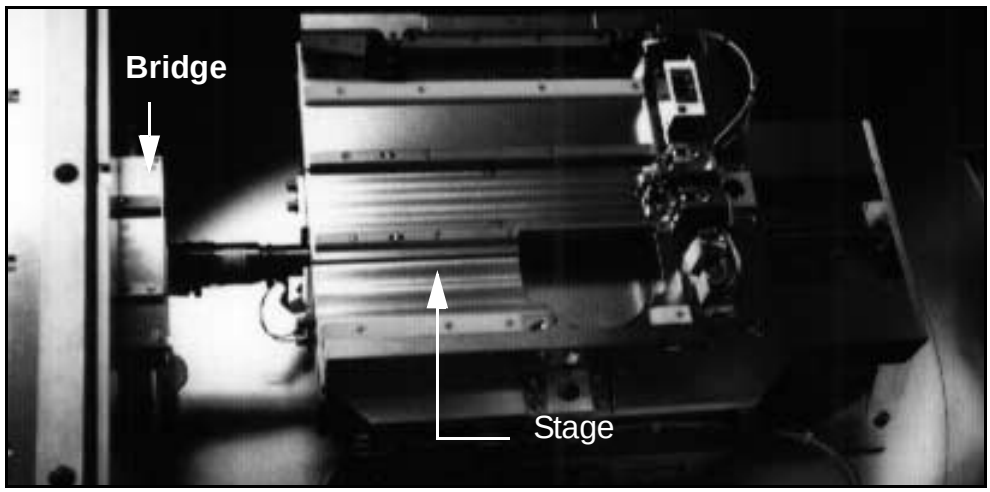


Figure 2. Aligning the Stage with the Loadlock

2-3. Place a straight-edge across the rails from the stage to the bridge. Align both the tops and the sides of the bridge rails with the straight-edge.

2-4. Use the straight-edge to verify a continuous plane along the top and sides of the brass rails between the bridge and the loadlock. Align the rails by lifting the loadlock up or down

within the bolt holes of the loadlock backing plate.

2-5. Finish the alignment with the transport carriage in the loadlock, and check the travel of the transport carriage as follows.

NOTE: Load position can also be changed if adjustment in the X axis is required.

2-6. With no sample holder loaded onto the transport carriage, check for smooth travel of the carriage between the loadlock and the stage:

a. Lower the velocity of the transport carriage so that any binding of the carriage will be obvious.

The default velocity setting is 60 (hexadecimal).

In an xterm window running the *vacchat* program, reduce the velocity to 20 (hex) by typing:

```
tv20
```

b. Type the following *vacchat* command to extend the carriage into the chamber:

```
ex
```

c. Check that the transport proceeds with no binding.

d. Type the *vacchat* command to retract the carriage into the loadlock:

```
re
```

e. Check that the transport retracts with no binding.

2-7. If the transport does not move, it may not be due to binding, but to a lack of sufficient voltage. Therefore, increase the tv setting by increments of 4 (hex) to make sure there is enough voltage to move the transport.

a. As soon as the transport moves, cycle the sample holder back and forth to check for binding.

b. When the procedure is finished, set the transport velocity back to its normal setting:

```
tv60
```

NOTE: Correct alignment can also be verified by disconnecting the carriage from the tape. By hand, shuttle the carriage from the load chamber across the bridge and onto the worktable. This will reveal any misalignment. Some bumps or tight spots may be detected, BUT do not always indicate poor or incorrect alignment. **Correct Alignment** is subjective to the “feel” of the Engineer.

2-8. When correct alignment is achieved, witness marks should be added to the top and side of the lock/valve body. The marks are perpendicular to the mating surfaces of the two components, (load chamber/valve body) and can be made with a small, sharp, cold chisel. A scribe line can be used if the above cannot be achieved. The load lock can now be removed and replaced with minimal to no alignment of the rails.

Micrion

Service Procedure No.: **06-05**
Service Procedure Title: **Process Module External Cleaning**
Applicable Systems: **All**
Frequency of Service: **Weekly, or prior to opening the system**

Introduction

This procedure describes how to clean the exterior of the process module.

Materials Required

- Clean-room gloves
- Lint-free wipes
- Laboratory grade isopropyl alcohol
- Clean-room vacuum cleaner
- N_2 blowgun with 30 psi pressure or greater
- High-intensity light

NOTICE

Per paragraph 11.1 of Safety Guidelines for Semiconductor Manufacturing Equipment (S2-93), this procedure is a Type 3 task. Specifically: "Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are less than 30 volts RMS, 42.2 volts peak, 240 volt-amps, and 20 Joules."

Power Down the System

Before performing the tasks described in this procedure, you must power down the system:

- If you are performing this procedure as part of routine weekly preventive maintenance, use the application software to place the system in "standby" mode.
- If you are performing this procedure prior to opening the workchamber, power down and vent the system as described in Service Procedure 01-02.
- Shine the high-intensity light on the surfaces at a low angle to properly highlight dust and dirt.

Part 1. Clean the External Surfaces of the Enclosure

1-1. Vacuum the surfaces of the top and side enclosure panels.

1-2. Use a lint-free wipe and clean-room compatible solvent to clean the surfaces of the top and side enclosure panels.

1-3. Remove the enclosure panels.

Part 2. Clean the External Surfaces of the Process Module

2-1. Vacuum the process module surfaces, including the top of the workchamber, the column, the loadlock area, the sides of the workchamber, and the mounting plate.

2-2. With the N_2 blowgun, blow off any areas that unreachable with the vacuum cleaner.

2-3. Use a lint-free wipe and clean-room compatible solvent to clean the process module surfaces.

2-4. Vacuum the system base plate and the floor around the system.

Part 3. Gaining Access to the Loadlock

If you are inspecting and cleaning the loadlock and do not wish to vent the workchamber, see Service Procedure 06-02.

Section 7: Deflection System

- 07-01 Lateral Axis Alignment *(Not included, not applicable)*
- 07-02 Scan Rotation Calibration
- 07-03 Scan Gain Calibration
- 07-04 Pan Gain Calibration
- 07-05 Pan Rotation/Ortho Calibration
- 07-06 Center of Rotation Calibration
- 07-07 Mux Shift Calibration
- 07-08 Reference Curve Calibration and Database Update

Micrion

Service Procedure No.: **07-02**
Service Procedure Title: **Scan Rotation Calibration**
Applicable Systems: **8000, Micrion 9800 FlipChip, MicroMill HT**
Frequency of Service: **After Column Alignment or Replacement**

Introduction

This procedure aligns the x scan axis with the x stage axis, then aligns the y scan axis so that it is orthogonal to the x scan axis. Misalignment can be caused by mechanical tolerances in the column, the chamber, the stage, and other subsystems. The outline of the procedure is as follows:

- Determine current x axis misalignment (in degrees)
- Adjust x axis alignment using R116 on Analog Drive board
- Measure new default x axis offset angle
- Determine current y axis misalignment (in degrees)
- Adjust y axis alignment using R103 on Analog Drive board

Materials and Tools Required

This procedure requires the following equipment:

- Fully operational stage and column (under vacuum)
- Small slotted screwdriver

NOTICE

Per paragraph 11.1 of Safety Guidelines for Semiconductor Manufacturing Equipment (S2-93), this procedure is a Type 3 task. Specifically: "Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are less than 30 volts RMS, 42.2 volts peak, 240 volt-amps, and 20 Joules."

Order of Deflection Procedures

- **Scan Rotation Calibration**
- Scan Gain Calibration
- Pan Gain Calibration
- Pan Rotation/Ortho Calibration

Part 1. System Preparation

1-1. Locate the Analog Drive board in the SysCon section of the electronics module. See Figure 1 for the location of the SysCon section, and Figure 2 for the factory configuration of the SysCon boards.

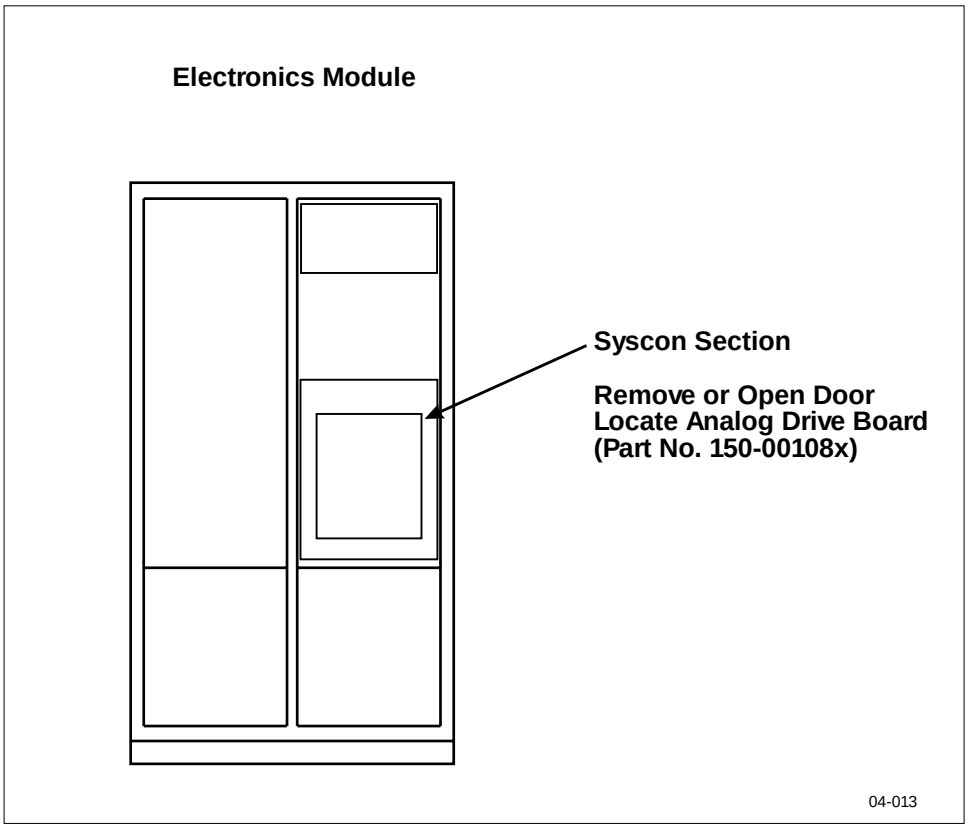
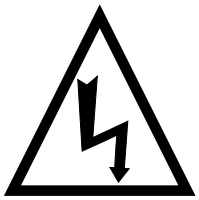


Figure 1. Electronics Module with SysCon Location.

1-2. If you need to put the Analog Drive board on an extender board, see Service Procedure 12-03. You will have to shut off power to the SysCon; see Service Procedure 01-02.

Figure 3 shows potentiometers R103 and R116.

WARNING



Dangerously high voltages are present in the process module while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and automatic procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

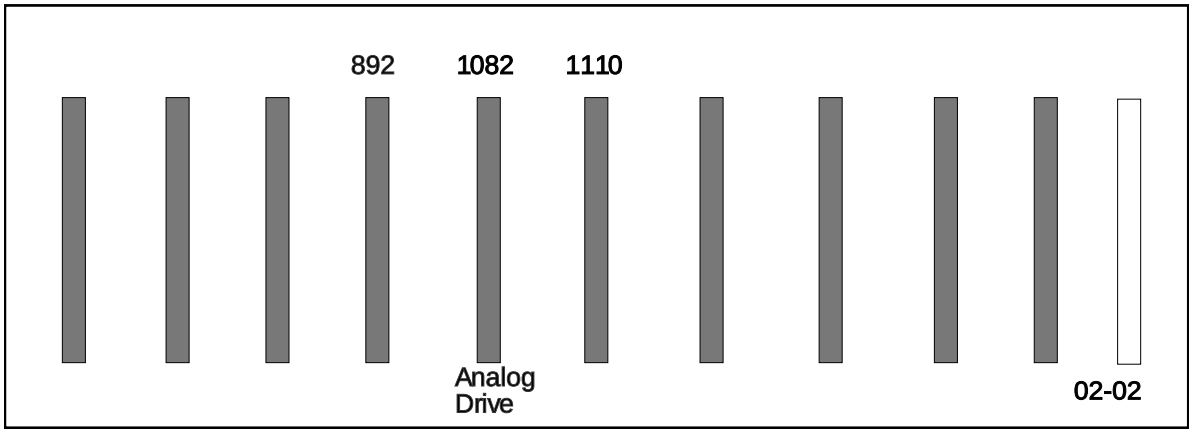


Figure 2. SysCon Boards: Factory Configuration

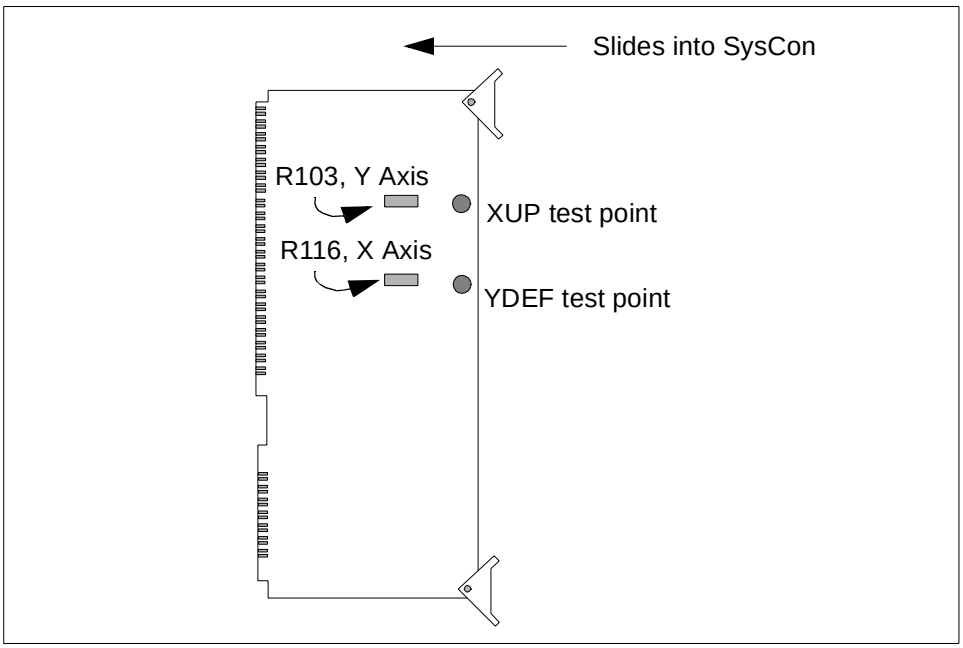


Figure 3. Analog Drive Board Potentiometers

1-3. With the power up, turn off *Scan Rotation Enable* on the Knob Panel.

1-4. Set the image mode to *Electron*. (Imaging is done without the flood gun for two reasons: 1) charge neutralization does not work well on the silicon grid, and 2) the electron flood causes staining on the grid.)

1-5. In the FIB application program, go to the silicon grid.

1-6. Locate one of the large boundary areas on the grid, shown in Figure 4.

1-7. Fine tune a small aperture beam (25-50 μm) on the grid.

Part 2. X Axis Calibration

2-1. By focusing on a spot with a 1 µm field of view for a few seconds, make two reference marks on the silicon grid 100 µm apart as follows:

a. Start a fast scan using the smallest screen image size.

b. Select a 1 µm field of view (FOV) in the thick boundary area of the silicon grid, as shown in Figure 4. The spot or mark must be visible once you zoom back out to a larger FOV.

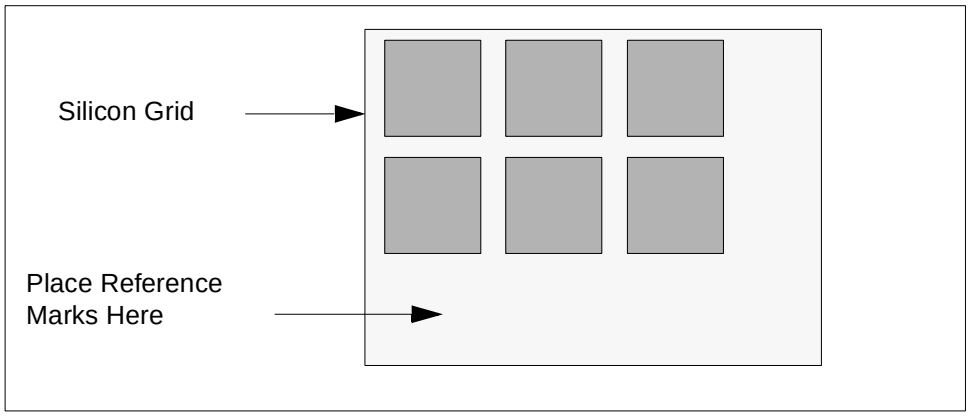


Figure 4. Image Area: Large Intersection of Silicon Grid.

c. Select 100 µm FOV. Using the Stage popup or the joystick, make a relative stage move of +100 µm in x. **Be careful not to move the joystick in the y direction**.

d. Zoom in to 1 µm FOV for a few seconds to make the second mark.

e. Zoom out to view the reference marks. Focus the image.

f. Stop imaging in Fast Scan mode.

2-2. Use the Point Crosshairs to align the x and y axis:

a. Turn on the Point Crosshairs feature by selecting *Misc* options *Point Crosshairs* from the menu bar at the top of the application program screen.

b. To display the cross hairs, click the left mouse button on the "+" sign in the array of X-Y Stage Motion Control ("stage arrows").

DO NOT click any mouse buttons while the cross hairs are displayed. Doing so causes the stage to move.

c. Place the cross hairs on the first reference mark, as shown in Figure 5.

2-3. Select *Fast Scan Start.* While imaging, adjust R116 (in the example shown in Fig. 5, turn counterclockwise) until the second reference mark lines up with the horizontal cross hair. Figure 6 shows the two reference marks on the x axis.

2-4. Use the Measure Tool in the FIB application program to verify that the x axis offset angle of the two reference marks is as close to zero as possible.

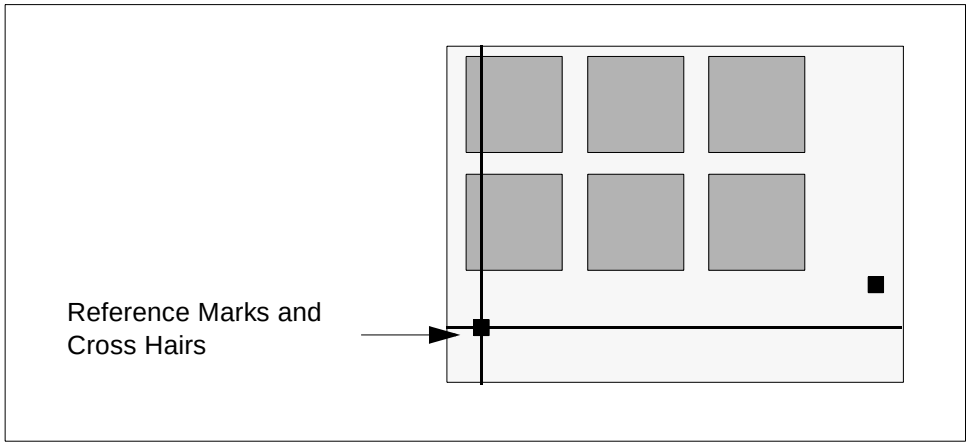


Figure 5. Reference Marks and Cross Hairs (exaggerated for demonstration).

Note: The angle of the grid is insignificant. Most important is the angle between the ref marks.

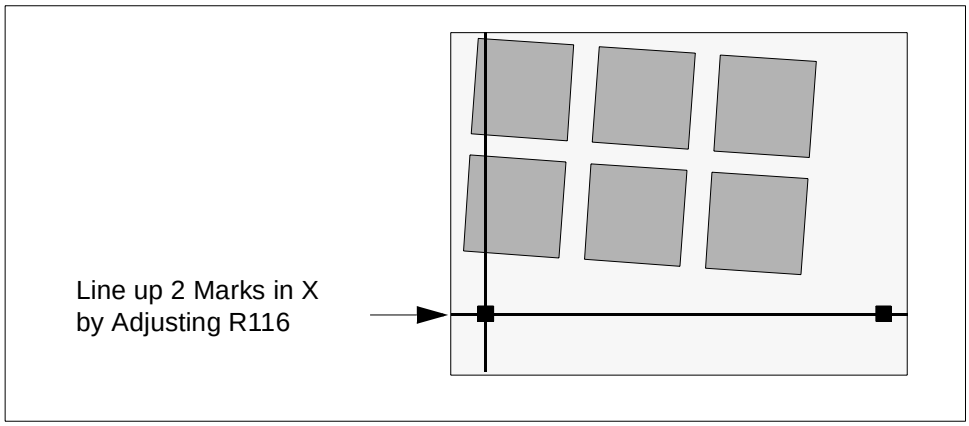


Figure 6. Adjust R116 for X Axis Alignment.

2-5. To realign the bottom of the silicon grid with the x axis, proceed as follows:

a. On the Knob Panel, turn on *Scan Rotation Enable*.

b. Adjust Scan Rotation until the Si grid x axis aligns with the horizontal cross hair, as shown in Figure 7.

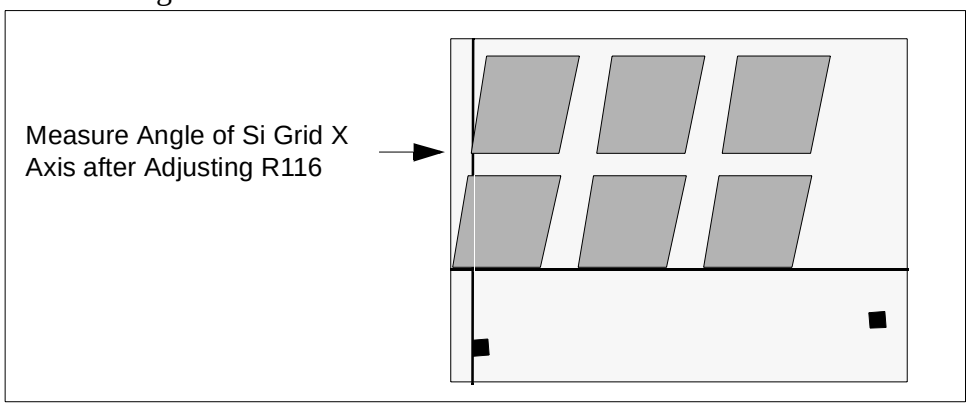


Figure 7. Align Si Grid X Axis to Cross Hair.

Part 3. Y Axis Calibration

3-1. Align the y axis of the silicon grid with the vertical cross hair. Place the y cross hair close to the edge of a column of silicon grid boxes, as shown in Figure 8.

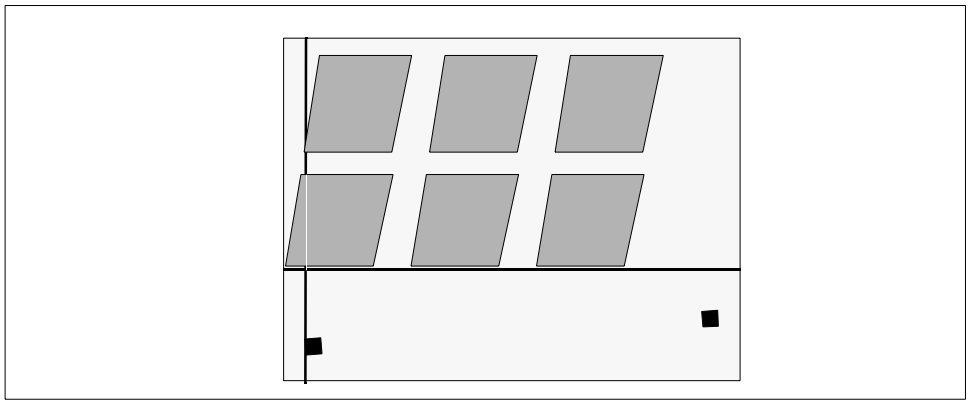


Figure 8. Line up Vertical Cross Hair and Si Grid.

3-2. Adjust R103 (upper pot in Figure 3) until the y axis of the silicon grid aligns with the vertical cross hair. In the example in Figure 8, adjust R103 clockwise. Figure 9 represents the result.

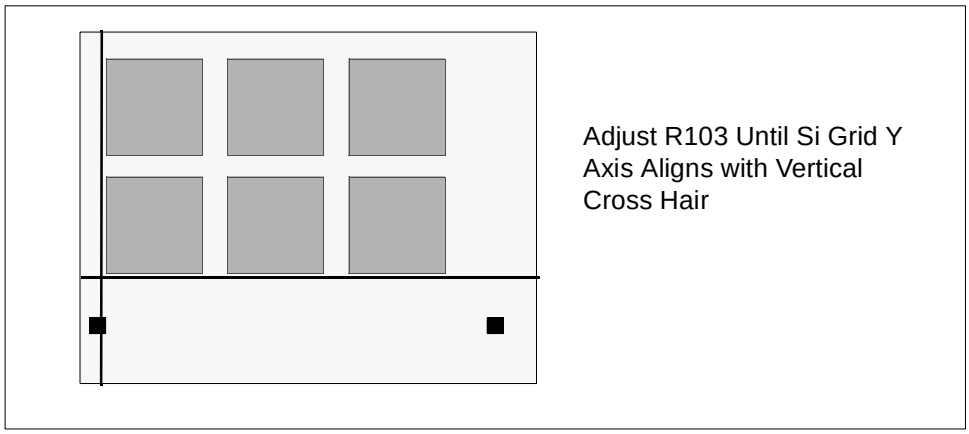


Figure 9. Adjust R103 for Y Axis Alignment.

3-3. Use the Measure Tool in the FIB application program to verify that the y axis offset angle is as close to zero as possible.

Micrion

Service Procedure No.: **07-03**
Service Procedure Title: **Scan Gain Calibration**
Applicable Systems: **8000, Micrion 9800 FlipChip, MicroMill HT**
Frequency of Service: **After Scan Rotation Calibration**

Introduction

Scan gain calibration calibrates the ion beam x/y deflection distance using the silicon grid as a reference. Errors in the deflection distance occur due to tolerances in the column, the chamber, the stage and other subsystems. There are two variables in the `/fib/data/Column.M` file used to calibrate the deflection gain: `Column_xcalgn` and `Column_ycalgn`.

Materials and Tools Required

- Fully operational stage and column
- Micrion Constants Editor or comparable text editor

Requirements and Order of the Procedure

This procedure should be performed in conjunction with these Micrion Service Procedures, and in this order:

- Scan Rotation Calibration
- **Scan Gain Calibration**
- Pan Gain Calibration
- Pan Rotation/Ortho Calibration

Part 1. Procedure

1-1. With the power up, turn off *Scan Rotation Enable* on the Knob Panel.

1-2. Set the image mode to *Electron*. (Imaging is done without the flood gun for two reasons: 1) charge neutralization does not work well on the silicon grid, and 2) the electron flood causes staining on the grid.)

1-3. Move the stage to the silicon grid.

1-4. Fine tune a beam with the 50 µm aperture. Display four silicon grid lines on the full screen, as shown in Figure 1. If necessary, turn on *Scan Rotation Enable* on the Knob Panel and adjust the image to 0° rotation.

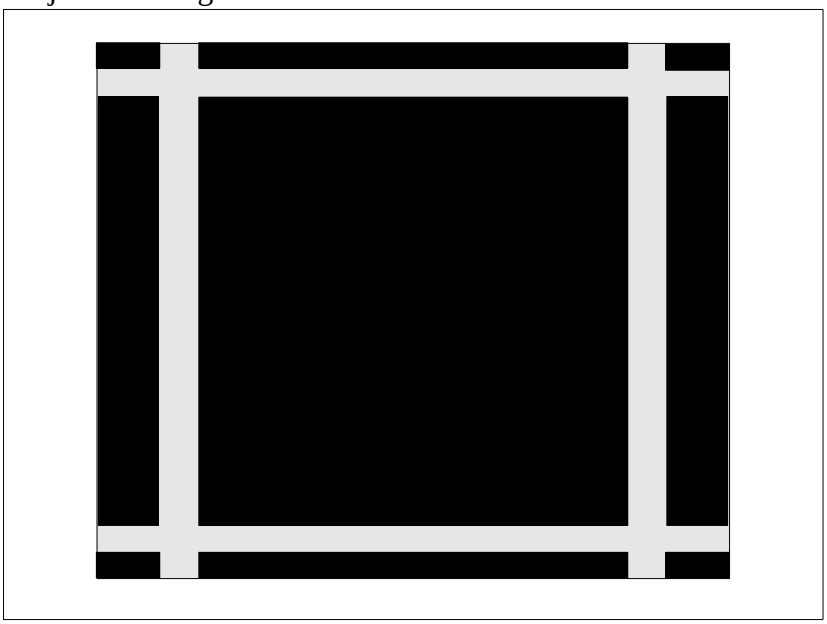


Figure 1. Full Screen Image of a Silicon Grid Box.

1-5. Using the Measure Tool, measure from the edge of one silicon grid line to the same edge of the next line, as shown in Figure 2. Record the measured values in your notebook.

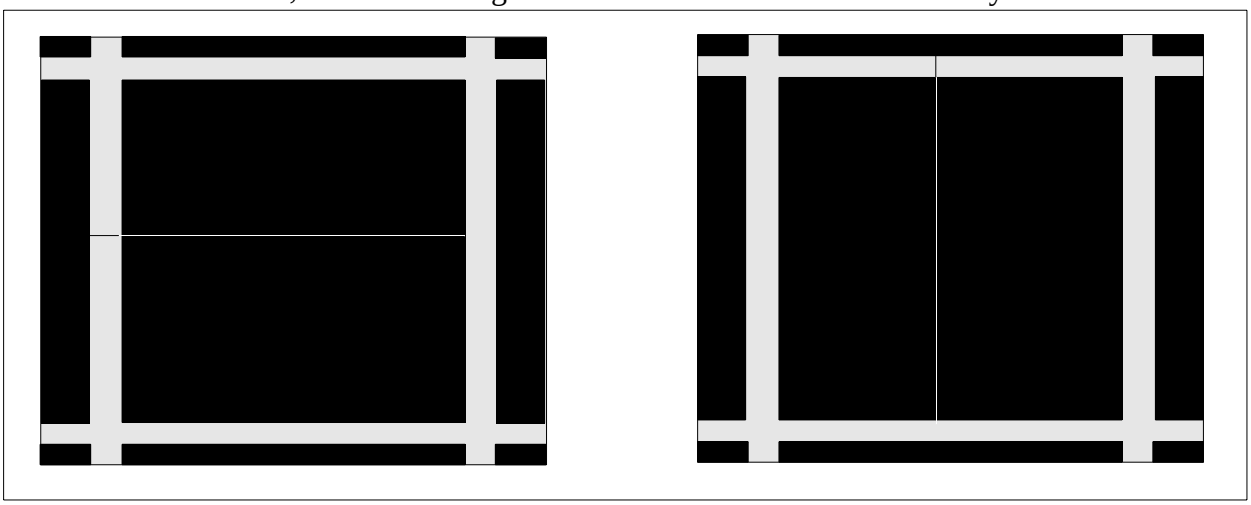


Figure 2. Measure a Silicon Grid Box in X and Y Axes.

1-6. Calculate new values for the `Column_xcalgn` and `Column_ycalgn` variables and insert them in the /`usr/micrion/fib/data/Column.M` file. Do this as follows:

a. Open the `Column.M` file using the Micrion Constants Editor.

Read the current values for the `Column_xcalgn` and `Column_ycalgn` variables, and record them in your notebook.

b. The Si grid lines are on 35 µm centers. Use this number, shown in the formula in Figure 3, to calculate new, more precise values for `Column_xcalgn` and `Column_ycalgn` variables.

:

To calculate the new value for Column_xcalgn:

$$\frac{\text{x value measured}}{35} \times \text{Column\_xcalgn current value} = \text{New Column\_xcalgn value}$$

To calculate the new value for Column_ycalgn:

$$\frac{\text{y value measured}}{35} \times \text{Column\_ycalgn current value} = \text{New Column\_ycalgn value}$$

Figure 3. Formula for More Precise Values of Column_scalgn and Column_ycalgn

c. Using the Micrion Constants Editor, insert the new values for `Column_xcalgn` and `Column_ycalgn` in the `/fib/data/Column.M` file.

d. For the changes in `Columns.M` to take effect, exit the X windows interface and the FIB application program by clicking the *Quit & Exit* button in the Process Watcher.

e. At the shell prompt (after exiting), restart the X window system and the application program by typing

```
xinit
```

1-7. Repeat steps 1-1 through 1-6 until the measured x and y values of the silicon grid lines are 35 +/- 0.05 µm. You can usually achieve a measurement of 35 +/- 0.02 µm.

Micrion

Service Procedure No.: **07-04**
Service Procedure Title: **Pan Gain Calibration**
Applicable Systems: **8000, Micrion 9800 FlipChip, MicroMill HT**
Frequency of Service: **After Scan Gain Calibration**

Introduction

Pan gain calibration measures the pan range and calibrates the coordinate display for panning. It calibrates the ion beam pan deflection distance. The pan circuitry must be calibrated so that the actual beam scanning distance is equal to the expected scanning distance. Calibration involves calculating and setting two (2) variables in the `/usr/micrion/fib/data/Column.M` file:

VariableIndex	Value
`Column_pan_cal0`	`(value)`
`Column_pan_cal1`	`(value)`

The variable with index = 0 calibrates the x axis, while index = 1 calibrates the y axis.

Materials and Tools Required

- Fully operational stage and column (under vacuum)
- Micrion Constants Editor or comparable text editor
- Notebook

Order of the Procedures

- Scan Rotation Calibration
- Scan Gain Calibration
- **Pan Gain Calibration**
- Pan Rotation/Ortho Calibration

Part 1. X Axis Pan Gain Calibration

1-1. With the power up, turn off *Scan Rotation Enable* on the Knob Panel.

1-2. Set the image mode to *Electron*. (Imaging is done without the flood gun for two reasons: 1) charge neutralization does not work well on the silicon grid, and 2) the electron flood causes staining on the grid.)

1-3. Locate one of the large boundary areas on the silicon grid (shown in Figure 1).

1-4. Using the 100 µm aperture, focus on the silicon grid under the following conditions:

- 1-2 µm field of view (FOV)
- On the Tasks pulldown menu, Readback is on

1-5. Rotate the *X Pan* knob counterclockwise as far as possible, and burn a reference mark. From the coordinate readout on the screen, record the current X position in your notebook as ***x1***. As shown in Table 1, an example value for x1 is 180602 µm.

1-6. Rotate the *X Pan* knob clockwise as far as possible, and burn a reference mark. From the coordinate readout on the screen, record the current X position in your notebook as ***x2***. As shown in Table 1, an example value for x2 is 180498 µm.

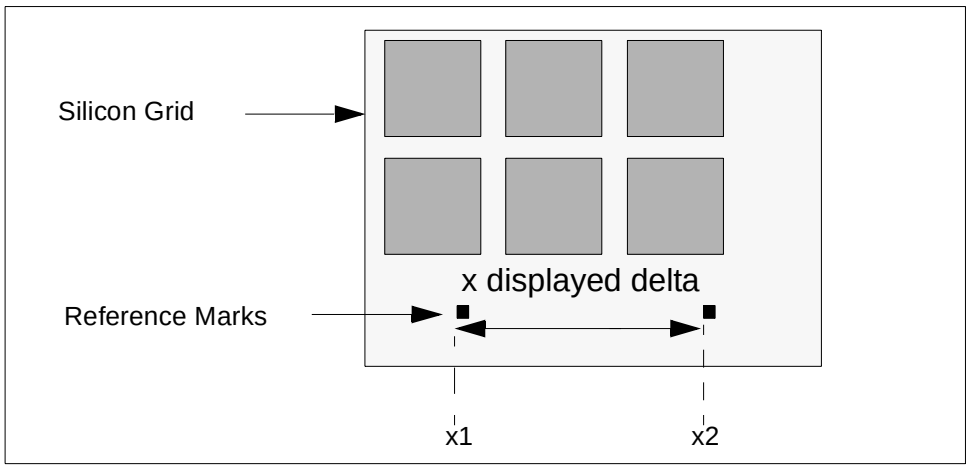


Figure 1. Image Area for X Axis Reference Marks

Table 1: Examples of values of X Displayed Delta and X Measured

Variables	Example Values	How calculated
x1	180602 µm	Pan knob counterclockwise
x2	180498 µm	Pan knob clockwise
x displayed delta	104 µm	180602 - 180498 = 104
X_m	100 µm	Measured distance, x1 to x2

1-7. The difference between ***x1*** and ***x2*** is ***x displayed delta; i.e., the difference between the displayed coordinates for x1 and x2.***

1-8. Zoom out to a FOV adequate to see both reference marks.

1-9. Using the Measure Tool, measure the distance between the reference marks, as shown in Figure 2. Refer to this value as X_m. ***This is the real distance from x1 to x2.*** In the example in Table 1, X_m is 100 µm.

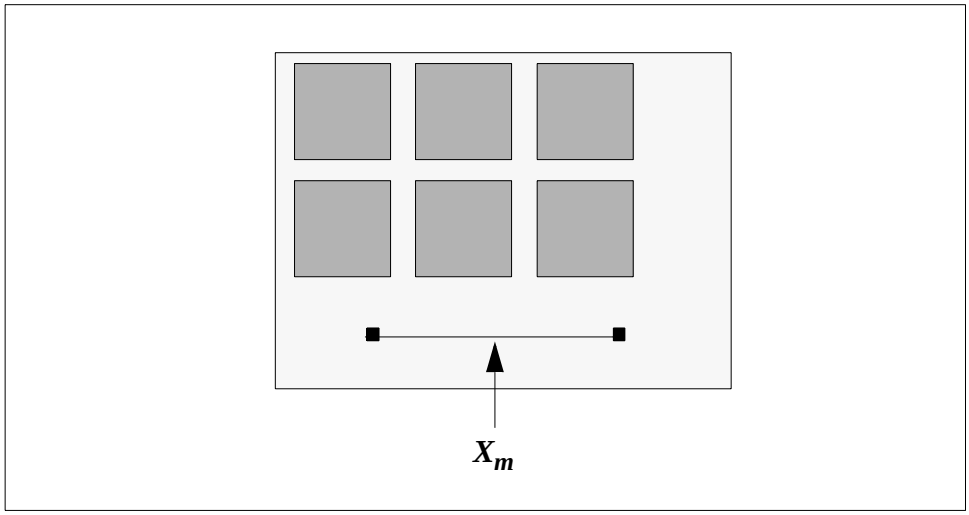


Figure 2. Measure Distance with Measuring Tool.

1-10. To make x displayed delta as close as possible to the measured value of y, calculate a new value for `Column_pan_cal` (index = 0; the x axis variable) as follows:

$$\frac{X_m}{\textbf{xstage delta}} \; x \; \textbf{Column\_pan\_cal (index = 0)} = \text{new value}$$

For example:

$$\frac{100}{104} \; x \; \textbf{Column\_pan\_cal (index = 0)} = \text{new value}$$

Given a `column_pan_cal` value of 30, then:

$$\frac{100}{104} \; x \; \textbf{30} = 28.84$$

1-11. Using the Micrion Constants Editor, edit the file `/usr/micrion/fib/data/Column.M` to change the `Column_pan_cal` variable to the value calculated in step 1-10.

```
Column_pan_cal0      <new value>
```

1-12. To save the new value of `Column_pan_cal` (index 0), exit the application program and the X window system with the *Quit & Exit* button in the Process Watcher.

1-13. To ensure that the application software is reading the new value for `Column_pan_cal` (index 0), restart the X window system and the application program by typing the following command at the shell prompt:

```
xinit
```

1-14. Repeat Part 1 until the measured value (X_m) is within +/- 0.5 µm of ***(x1-x2)***.

Part 2. Y Axis Pan Gain Calibration

2-1. Locate one of the large boundary areas on the silicon grid, as shown in Figure 3.

2-2. Using the 100 µm aperture, focus on the silicon grid under the following conditions:

- 1-2 µm field of view
- On the Tasks pulldown menu, *Readback* is on

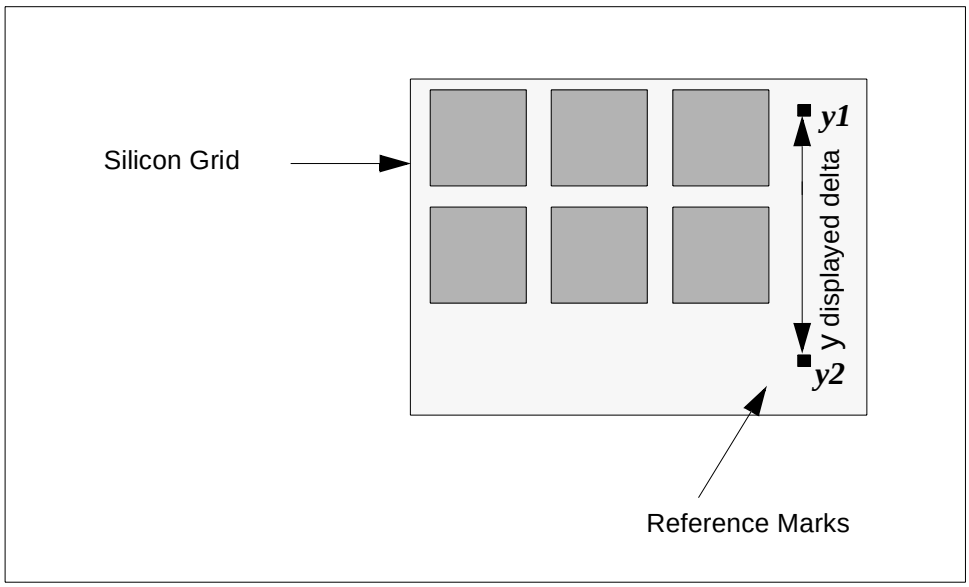


Figure 3. Image area for Y Axis Reference Marks

2-3. Be sure that on the Tasks pulldown menu, *Readback* is on.

Table 2: Examples of values of Y Displayed Delta and Y Measured

Variables	Example Values	How calculated
y1	49878 µm	Pan knob ccw all the way
y2	49811 µm	Pan knob cw all the way
y displayed delta	67 µm	49878 - 49811 = 67
Y_m	70 µm	Measured distance, y1 to y2

2-4. Rotate the *Y Pan* knob counterclockwise and burn a hole. Record the Y position in your notebook as ***y1***.

2-5. Rotate the *Y Pan* knob clockwise and burn a hole. Record the current Y position in your notebook as ***y2***.

2-6. The difference between ***y1*** and ***y2*** is ***y displayed delta; i.e., the difference between the displayed coordinates for y1 and y2.***

2-7. Zoom out to a FOV adequate to image both reference marks.

2-8. Using the Measure Tool, measure the distance between the holes, as shown in Figure 4. Refer to this value as ***Y_m. This is the real distance from y1 to y2.***

2-9. To make y displayed delta as close as possible to the measured value of y, calculate a new value for `Column_pan_cal`(index = 1; the y axis variable) as follows:

$$\frac{Y_m}{ystage\ delta} \times Column\_pan\_cal\ (index = 1) = \text{new value}$$

For example:

$$\frac{70}{67} \times Column\_pan\_cal\ (index = 1) = \text{new value}$$

Given a column_pan_cal value of 24, then:

$$\frac{70}{67} \times 24 = 25.07$$

2-10. Using the Micrion Constants Editor, edit the file `/usr/micrion/fib/data/Column.M` to change the `Column_pan_cal` variable to the value calculated in step 2-9.

```
Column_pan_cal1      <new value>
```

2-11. To save the new value of `Column_pan_cal` (index 1), exit the application program and the X window system with the *Quit & Exit* button in the Process Watcher.

2-12. Restart the X window system and the application program. To make sure the application software is reading the new value for `Column_pan_cal` (index 1), type the following command at the shell prompt:

```
xinit
```

2-13. Repeat Part 2 until the measured value Y_m is within +/- 0.5 µm of ($y1$ -$y2$).

.

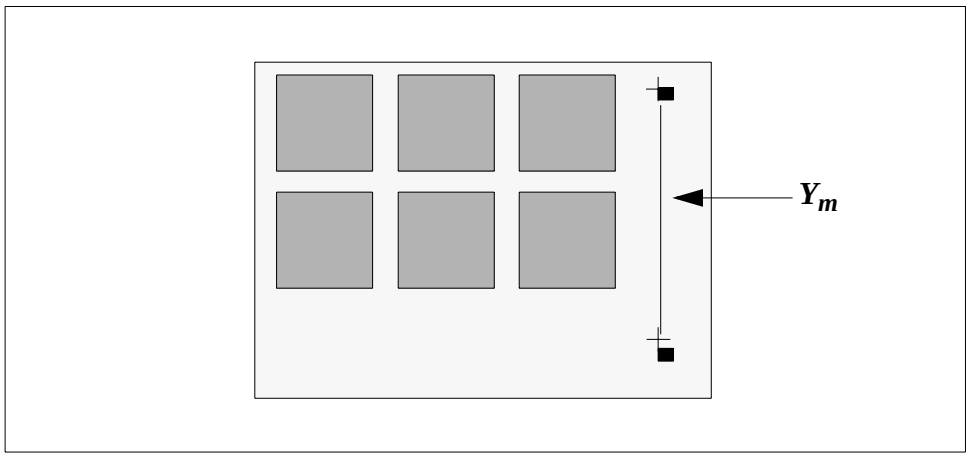


Figure 4. Examine Reference Marks with Measuring Tool

Micrion

Service Procedure No.: **07-05**
Service Procedure Title: **Pan Rotation/Ortho Calibration**
Applicable Systems: **8000, Micrion 9800 FlipChip, MicroMill HT**
Frequency of Service: **After Pan Gain Calibration**

Introduction

Due to tolerances in the stage, the chamber, and the column, there is always a slight inherent misalignment of the stage vs. the pan deflection axis. The system software and column electronics compensate for this misalignment. Pan rotation/Ortho calibration aligns the ion beam Pan X-Y deflection axis with the X-Y stage travel axis. Calibrating the Pan Rotation involves calculating and setting two variables in the `/usr/micrion/fib/data/Column.M` file:

`Column_square`	Aligns Pan x axis with stage x axis
`Column_ortho`	Sets Pan y axis perpendicular to the Pan x axis

The variable with index = 0 calibrates the x axis, while index = 1 calibrates the y axis.

In setting xpan (steps 1-6 and 1-8) **and ypan** (steps 2-5 and 2-7), the integer may be as low as 7 or as high as 10.

Materials and Tools Required

- Fully operational stage and column (under vacuum)
- Micrion Constants Editor or comparable text editor

Order of the Procedures

- Scan Rotation Calibration
- Scan Gain Calibration
- Pan Gain Calibration
- **Pan Rotation/Ortho Calibration**
- Locate Center of Rotation.

Part 1. Pan Rotation Calibration (Xpan)

1-1. Make sure that the *Scan Rotation Enable* switch on the Knob Panel is not enabled.

1-2. Set the Image mode to *Electron*.

1-3. Focus the beam over the Silicon Grid using a 100 µm aperture at the *Depo* working distance and 0° tilt.

1-4. Open the *adshell* in an xterm window by typing

```
adshell
```

Set `xpan` and `ypan` equal to 0. (`Xpan` and `ypan` set the lower octopole offset.)

```
xpan 0
ypan 0
```

1-5. Locate one of the large border areas on the silicon grid, similar to that shown in Fig. 1.

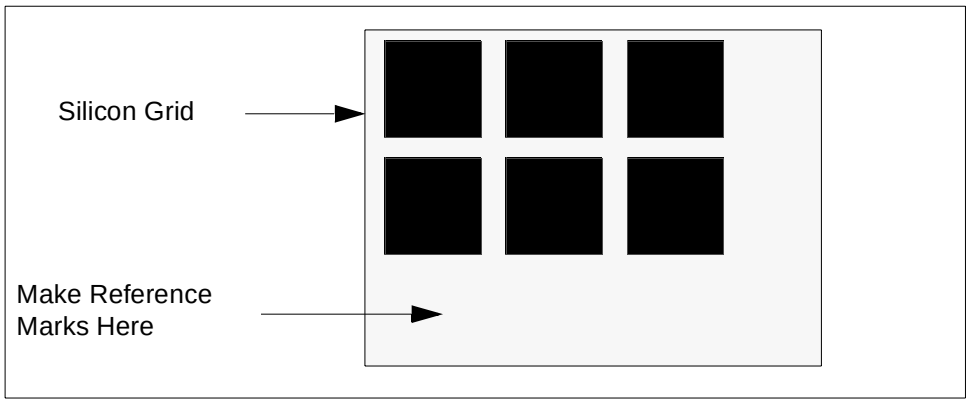


Figure 1. Image Area: Large Intersection of Silicon Grid.

1-6. Set `xpan` equal to 10 in *adshell*.

```
xpan 10
```

1-7. Start imaging, and zoom in to a 1 µm FOV. Continue imaging for several seconds (to create a reference mark), and then stop imaging.

1-8. Set `xpan` equal to -10 in *adshell*.

```
xpan -10
```

(If adshell message says "`Don't Understand`," try again.)

1-9. Start imaging (to create a second reference mark that is offset by -10 µm in x).

1-10. After several seconds, stop imaging.

1-11. Zoom out to a FOV adequate to image the two reference marks. They should look similar to Fig 2, with some offset angle θ possible in x.

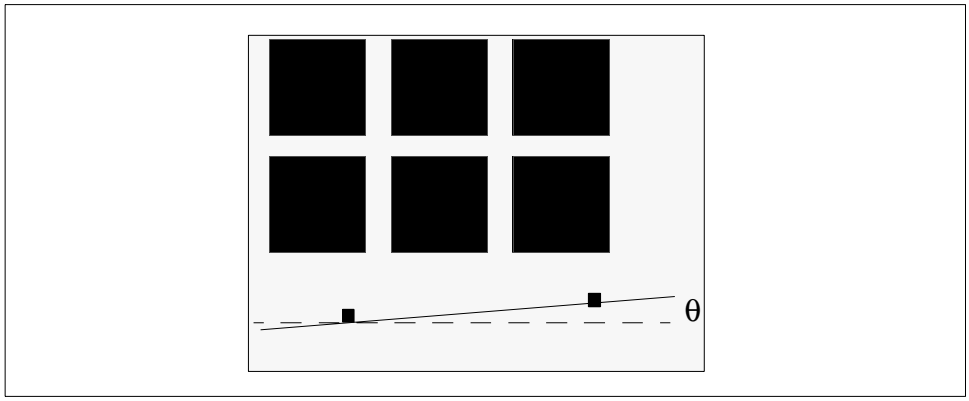


Figure 2. X Pan Offset Reference Marks.

1-12. Use the Measure Tool to measure the offset angle θ from left to right between the two reference marks. Record the value for θ in your notebook.

Using the Micrion Constants Editor, open the `/fib/data/Column.M` file.

Read the current value for `Column_square`, and record it in your notebook.

1-13. Use θ to calculate the new value for `Column_square` as follows:

Column_square (old value) - θ = Column_square (new value)

For example, if the old value of column_square is .64, and Theta (θ) is .74, then:

.64 - .74 = -.10, which is the new value for `Column_square`.

1-14. Type the newly calculated value of `Column_square` in the `Column.M` file.

1-15. Exit the application program and the X window system by clicking the *Quit & Exit* button in the Process Watcher.

1-16. At the shell prompt, restart the X window system and the application program by typing:

```
xinit
```

1-17. Repeat steps 1-3 through 1-12 to verify that the new value for `Column_square` is calibrated so that the angle θ is as close to 0° as possible for x.

1-18. Reset `xpan` and `ypan` to 0 in *adshell*. If your application software is version 1.1 or earlier, do not continue with this procedure. If the application software is version 1.2 or later, go on to the next section.

Part 2. Pan Ortho Calibration (Ypan)

2-1. Set the Image mode to *Electron*.

2-2. Focus the beam over the Silicon Grid using a 100 µm aperture at the *Depo* working distance and 0° tilt.

2-3. Locate one of the large boundary areas on the grid, similar to Fig 3.

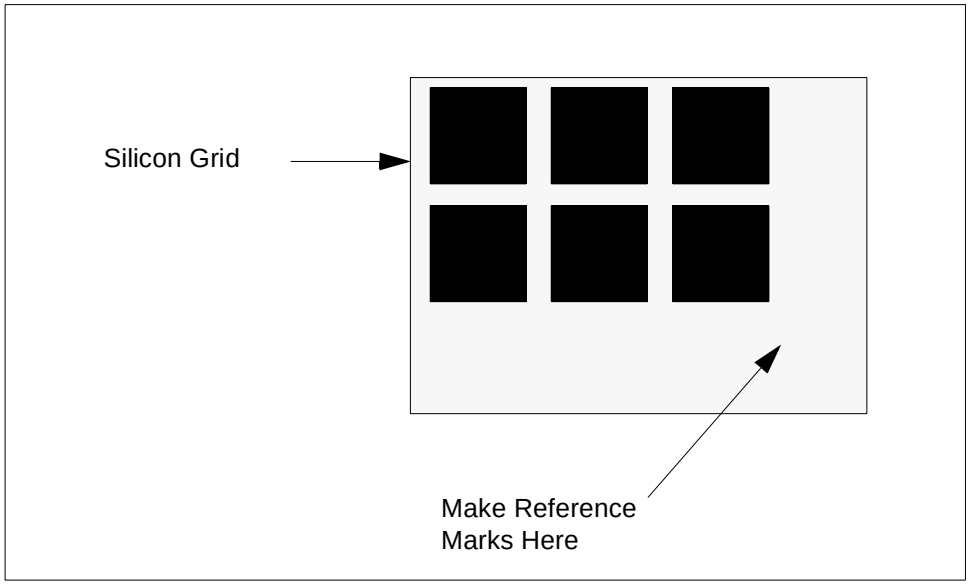


Figure 3. Image area for Y Axis Reference Mark.

2-4. Open the *adshell* in an xterm window by typing

```
adshell
```

Set `xpan` and `ypan` equal to 0. (`Xpan` and `ypan` set the lower octopole offset.)

```
xpan 0
ypan 0
```

2-5. In *adshell*, set `ypan` equal to 10.

```
ypan 10
```

2-6. Start imaging, and zoom in to a 1 µm FOV. Continue imaging for several seconds (to create a reference mark), and then stop imaging.

2-7. Set `ypan` equal to -10.

```
ypan -10
```

2-8. Make a second 1 µm reference mark on the Si grid, offset by -25 µm in the y pan axis.

2-9. Zoom out to a FOV adequate to image the two reference marks. They should look similar to the image in Fig. 4, with offset angle ρ (rho) in the y pan axis.

2-10. Use the Measure Tool to measure angle ρ from bottom to top between the two reference marks, as in Fig. 4. Record the value for ρ in your notebook.

Open the `/fib/data/Column.M` file.

Read the current value for the `Column_ortho`, and record it in your notebook.

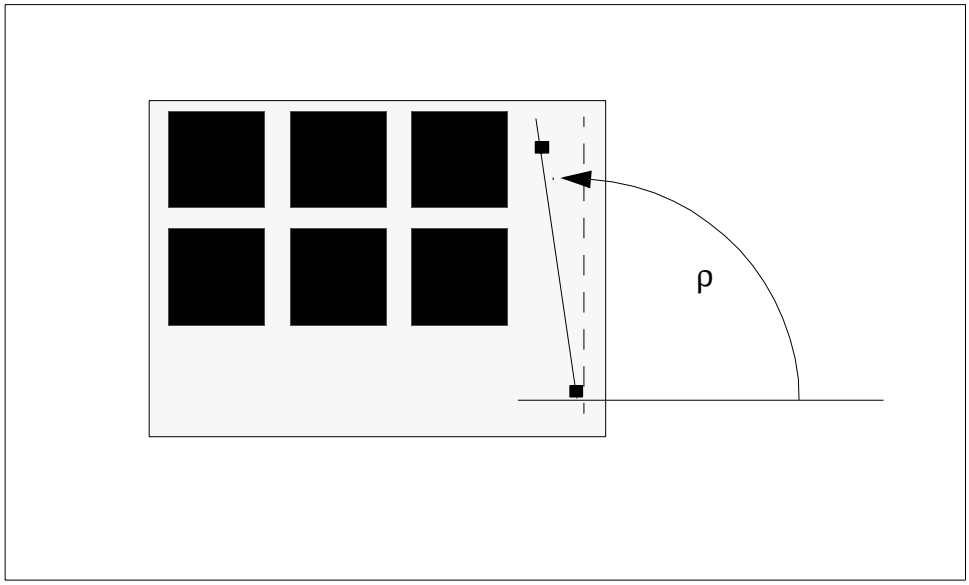


Figure 4. Y Pan Offset Reference Marks.

2-11. Use ρ to calculate the new value for the variable `Column_ortho` as follows:

Column_ortho (old value) - 90 + ρ = Column_ortho (new value)

For example, if the old value of column_ortho is 1.14 and Rho (ρ) is 90.99°, then:

1.14 + (- 90 + 90.99) = 2.13

2-12. Type the newly calculated value for `Column_ortho` in the `Column.M` file.

2-13. To save the new value of `Column_ortho`, exit the application program and the X window system by clicking the *Quit & Exit* button in the Process Watcher.

2-14. At the shell prompt, restart the X window system and the application program by typing:

```
xinit
```

2-15. Repeat steps 2-2 through 2-10 to verify that the new value for `Column_ortho` is calibrated so that the angle ρ for a y pan mill is as close to 90° as possible.

Micrion

Service Procedure No.: 07-06
Service Procedure Title: Check the Center of Rotation
Applicable Systems: 8000, MicroMill HT, Micrion 9800 FlipChip
Frequency of Service: After Pan Rotation/Ortho Calibration

Introduction

This procedure checks the ROT_CENTER (center of rotation) stage label, which is the stage address that locates (as closely as possible) the center of the stage.

Materials and Tools Required

- Fully operational stage and column (under vacuum)

Order of Procedures In This Series

- Lateral Axis Calibration
- Scan Rotation Calibration
- Scan Gain Calibration
- Pan Gain Calibration
- Pan Rotation/Ortho Calibration
- **Locate Center of Rotation**

Part 1. Finding the Center of Rotation

The object is to bring the center of the stage under the ion beam column.

1-1. Switch off *Scan Rotation Enable* on the control (knob) panel.

1-2. Go to the current ROT_CENTER:

1-3. Click on the *Stage* icon to get the *Stage Control* popup.

1-4. Select the ROT_CENTER label.

1-5. Click on *Go To Label*.

1-6. Check the Coordinate Display to make sure that the stage is close to center (within about 1000 microns of 100,000 in x and 100,000 in y).

Part 2. Re-labeling the Center of Rotation

With the stage positioned as described above, in the *Stage Control* popup, select the ROT_CENTER label.

2-1. Click on the *Delete Label* button.

2-2. Click on the *Add Label* button.

Micron

Service Procedure No.: **07-07**
Service Procedure Title: **Mux Shift Calibration**
Applicable Systems: **8000, Micron 9800 FlipChip**
Frequency of Service: **Every two weeks; see also “When Needed” below**

Introduction

This is an eyeball calibration and should be done during milling.

You perform one sample repair; note the coordinates for the screen location of the box and perform a mill or a deposition. If the mill or deposition is offset from the repair box, you move the defined box till it overlays the mill or the depo.

Note the new coordinates and edit the *Imagemode.M* file accordingly.

When Needed

Mux shift should be calibrated when the source is stable, before doing edge locks, and after the following:

- Aperture blade replacement
- Flood gun calibration in ion or mux mode
- Power Up
- MCP change
- Funnel height change
- Funnel re-dag

Materials and Tools Required

None

Part 1. Mux Shift Calibration: Sample Repair

Perform one sample repair as follows.

1-1. Over a chrome area of the mask, define an image at FOV 10 μm and 1024 pixel resolution.

1-2. Using the *Box Modify* tool, draw a repair box at the top of the image screen. Define the box as x=0 and y=4, with a 1 μm height and 1 μm width. Note the box coordinates.

1-3. Take an image of the repair box. When the scan has covered the repair box, terminate it.

1-4. Select *Default_mill* from the mill types.

1-5. Begin the repair. When the repair is finished, immediately start a scan; terminate the scan when it has covered the repair box and the mill.

1-6. See if the mill is made inside the repair box. If the repair area is not within the repair box, move the repair box to overlay the repair area..

In moving the repair box to the repair area, the x, y location of the repair box is shifted.

By calling up the *Box Modify* popup, you can see how much the repair box has been offset in X and/or Y.

Edit the *Imagemode.M* file.

In the Micrion Process Watcher popup, open the Micrion Constants Editor. In the *Imagemode.M* file, edit the settings to shift X and Y according to the offset you saw in step 1-7. In *Imagemode.M*, the settings for the two lines in the 0 index are the only ones to change. At end of *Imagemode.M* is a section headed:

```
The following are the Mux shifts
```

In this section are important listings:

```
Image_shiftx
Image_shifty
```

Let's say that the settings are as follows:

```
Image_shiftx 0 0.05
Image_shifty 0 0.00
```

1-7. Edit the settings following these four rules:

•If the repair area is shifted to the left of the repair box, make *Image_shiftx* more positive.
•If the repair area is shifted to the right, make *Image_shiftx* more negative.
•If the repair area is shifted down, make *Image_shifty* more positive.
•If the repair area is shifted up, make *Image_shifty* more negative.

For example, assuming a -0.03 offset in X, edit the *Image_shiftx* line as follows:

```
Image_shiftx 0 0.08
```

1-8. Save the setting and perform another mill.

1-9. Define a new repair box over another chrome area, and define it as X = 2, Y = 4. Perform a mill and see if there is some offset. If so, change *Imagemode.M* again.

Micrion

Service Procedure No.: **07-08**
Service Procedure Title: **Reference Curve Calibration and Database Update**
Applicable Systems: **8000, Micrion 9800 FlipChip**
Frequency of Service: **As needed.**

Introduction

The reference curve data base is a collection of histograms and edge profiles; it is one of the Misc options. Due to the differences in masks, there should be a reference curve profile entered in the database for each type of mask. Reference curves, also called model curves, are used in edge placement during repair. There are two types of reference curves: Edge Lock and ABB.

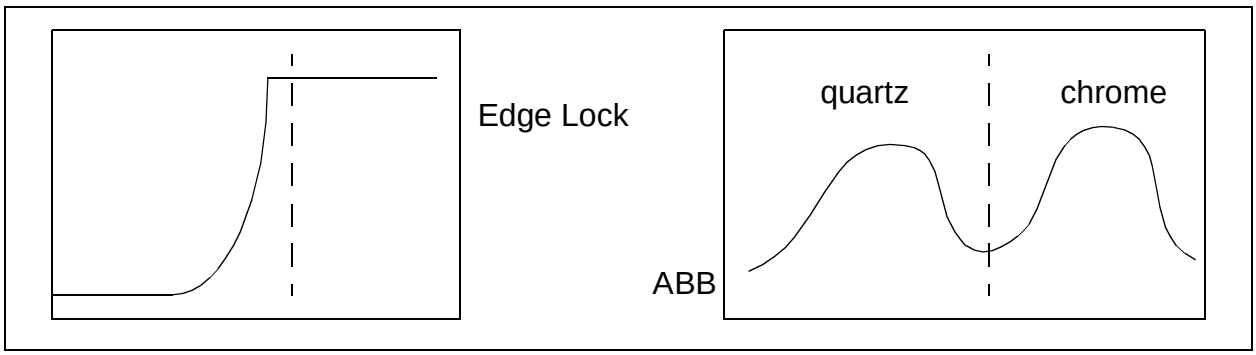


Figure 1. Reference Curves: Edge Lock and Adaptive Beam Blanking

In this procedure, immediately after creating a new reference curve you assign it to either an expansion file (Edge Lock) or to a repair type (ABB). A standard curve may be assigned to more than one repair type or more than one expansion file. For example, a standard edgelock curve for a certain mask may be assigned to two different expansion files: one of the expansion files used for opaque repairs on that mask, and the other expansion file used for clear repairs.

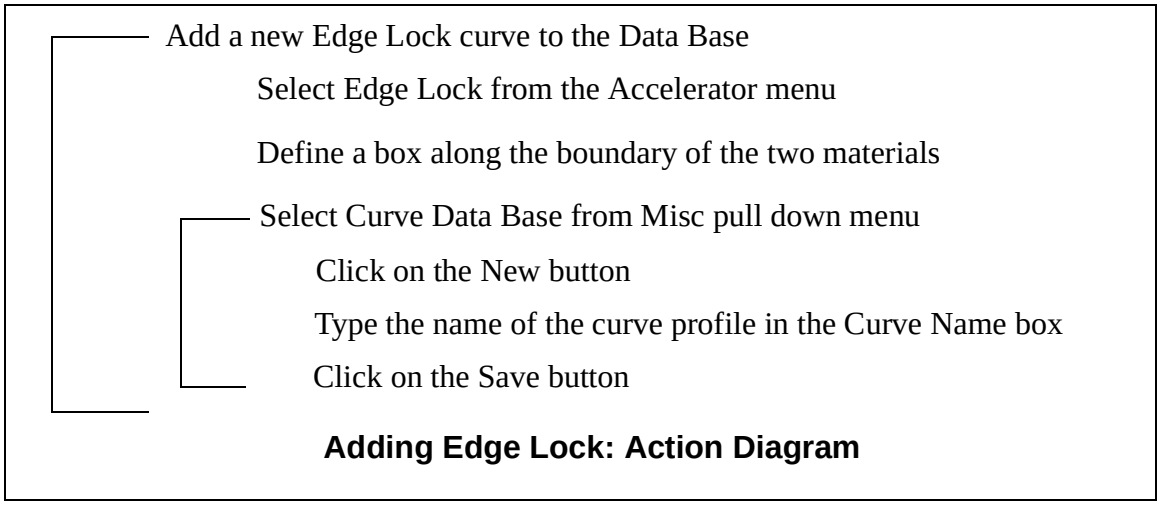
Graphic User Interface Conventions

- Press the *Return* or *Enter* key when changing names in boxes.
- Clicking on the *Save* button saves all current information from the displayed window.
- Closing any window without saving means all changes are lost.
- Clicking the *Assign* button in the Create Expansion Factors window assigns the highlighted file in the Expansion Name box to the Expansion File box in the Create Repair Types window.
- To change an edge definition on an Edge Lock curve, click the *Change* button, move the pointer to the position, and click the left mouse button to add a yellow line at the new boundary; the middle button deletes the yellow line.

The following action diagrams are shorthand expressions of the individual procedures.

Part 1. Add a New Edge Lock Curve to the Data Base

Perpendicular to the line where chrome meets quartz, a raster is performed in 10 different places along that line. The 10 samples are averaged to give a curve that shows the rate of change from black to white.


Add a new Edge Lock curve to the Data Base
Select Edge Lock from the Accelerator menu
Define a box along the boundary of the two materials
Select Curve Data Base from Misc pull down menu
Click on the New button
Type the name of the curve profile in the Curve Name box
Click on the Save button

Adding Edge Lock: Action Diagram

1-1. In the image field, click the right mouse button to produce the Accelerator pull-down menu; then select Edge Lock.

An Edge Lock Profile window appears; the window is empty of any edge lock histograms.

1-2. Define the Edge Lock box as follows:

a. Center the cursor cross hair on the reference edge.

b. Click the left mouse button, drag the mouse to form the edge lock line at the boundary.

c. Click the left mouse button to close the boundary of the box.

In the Edge Lock Profile window, the edge lock curve profile of the material is shown. The program scans the profile, calculates the intensity of the image, and converts it to a histogram.

1-3. In the Misc pull down menu, select Curve Data Base.

1-4. From the Curve Data Base Manager window, select the New button.

The current edge lock profile in the Edge Lock Profile window is placed in the Curve Data Base Manager window with the default name Temp Curve.

1-5. In the Curve Data Base Manager, perform the following:

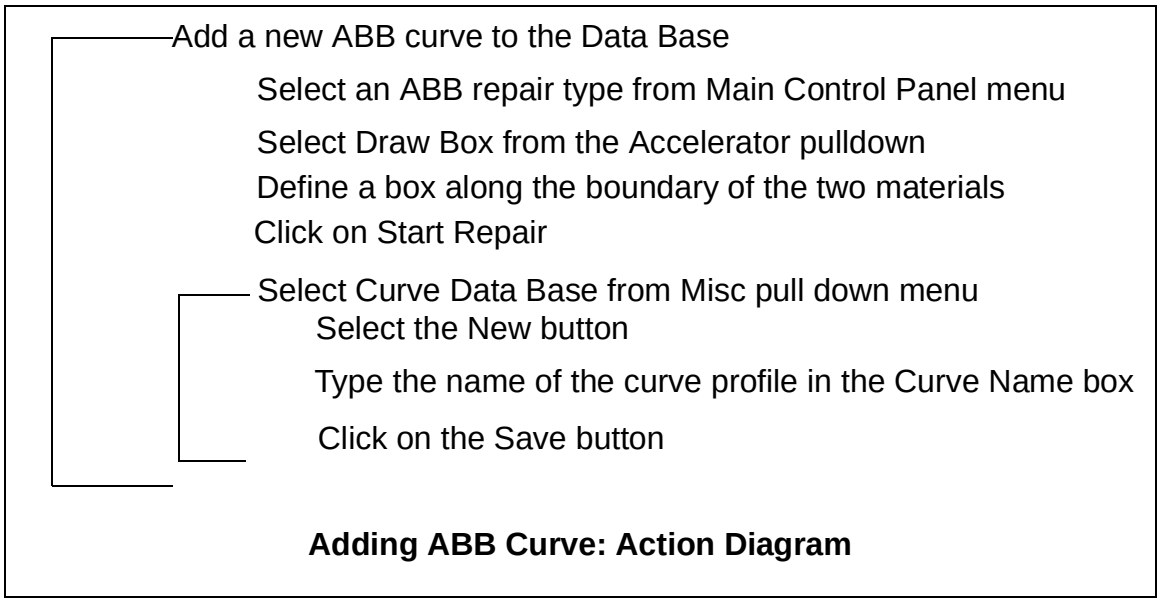
a. Click on the Curve Name box.

b. Type the name of the profile (for example, *XYZ*) and press Enter.

c. Click on Save. Two messages appear: “Saving changes in database...” and “Done!”

Part 2. Add a New ABB Curve to the Data Base

Adaptive Beam Blanking curves can be resized. As the operator chooses, the line that marks the boundary between black and white areas can be moved.


Add a new ABB curve to the Data Base
Select an ABB repair type from Main Control Panel menu
Select Draw Box from the Accelerator pulldown
Define a box along the boundary of the two materials
Click on Start Repair
Select Curve Data Base from Misc pull down menu
Select the New button
Type the name of the curve profile in the Curve Name box
Click on the Save button

Adding ABB Curve: Action Diagram

2-1. Image the area at the FOV at which you will make your repairs.

2-2. From the Defect Control area of the main Control Panel menu, select an existing ABB repair type (for example, *ABB*).

2-3. In the image field, click the right mouse button to produce the Accelerator pull-down menu; select the Draw Box feature.

2-4. In the image window, draw a box over a typical boundary area, so the box contains roughly equal amounts of the two contrasting materials.

2-5. Click on the Start Repair button in the main menu.

The Box Repair Progress pie chart appears. An inverted ABB image appears in the upper left corner of the display; an image intensity histogram appears in the ABB window.

2-6. From the Misc pulldown menu, select Curve Data Base.

The Curve Data Base Manager window appears.

2-7. In the Curve Data Base Manager, select the New button.

The current image intensity histogram in the Adaptive Beam Blanking window is placed in the Curve Data Base Manager window with the default name Temp Curve.

2-8. In the Curve Data Base Manager window, proceed as follows:

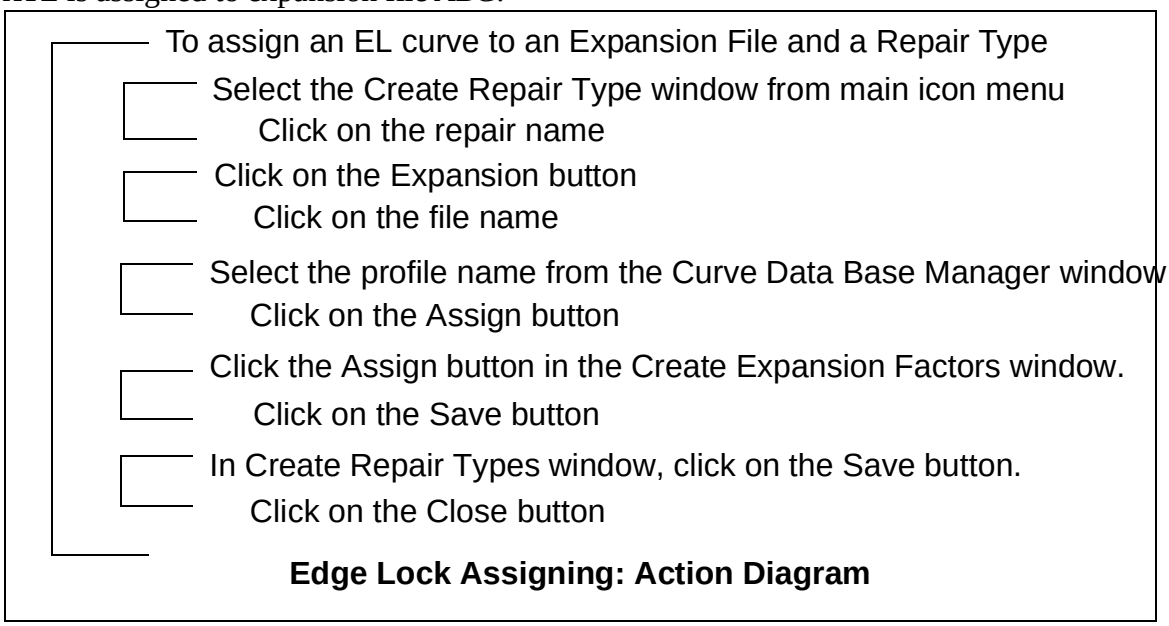
a. Click on the Curve Name box.

b. Type the name of the curve profile (for example, *RST*) and press Enter.

c. Click on Save. The messages appear: “Saving Changes in Database” and “Done!”

Part 3. Assign an Edge Lock Curve to An Expansion File

In the following steps, expansion file *ABC* is assigned to repair type *PDQ;* then edge lock curve *XYZ* is assigned to expansion file *ABC*.


To assign an EL curve to an Expansion File and a Repair Type
Select the Create Repair Type window from main icon menu
Click on the repair name
Click on the Expansion button
Click on the file name
Select the profile name from the Curve Data Base Manager window
Click on the Assign button
Click the Assign button in the Create Expansion Factors window.
Click on the Save button
In Create Repair Types window, click on the Save button.
Click on the Close button

Edge Lock Assigning: Action Diagram

3-1. Call up the Create Repair Type window by clicking on RT in the main icon menu.

3-2. In the Create Repair Type window, click on a repair name (for example, *PDQ*); the name appears in the Repair Name box. This is the repair type that the expansion factors file will be related to. You can assign an expansion file to more than one repair type.

3-3. Click on the Expansion button.

The Create Expansion Factors window appears. The next step is to relate an expansion factors file to repair type *PDQ.*

3-4. In the Create Expansion Factors window, select a file name (for example, *ABC*).

3-5. The selected name *ABC* appears in the Expansion Name box. This is the expansion type to which the new curve *XYZ* will be assigned. The name in the Create Expansion Factors/ Expansion Name box is the same as in the Create Repair Types/Expansion File box. To assign the curve to the Expansion File, click on *XYZ* in the Curve Database window.

3-6. On the Curve Data Base Manager menu, select the Assign button. The message appears:

```
Saving Curve XYZ to Expansion Type ABC.
```

The curve name, *XYZ*, appears in the Standard Curve File box.

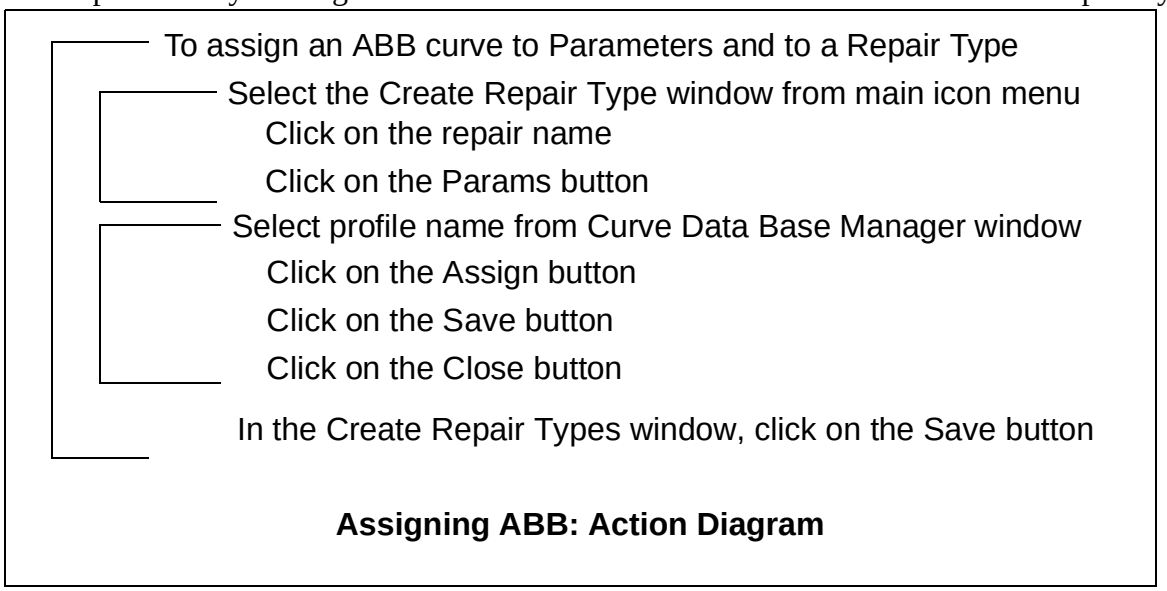
3-7. To assign Expansion File *ABC* to Repair Type *PDQ*, select the Assign button in the Create Expansion Factors window.

3-8. To save the Expansion File to the Repair Type, in the Create Expansion Factors window click on the Save button.

3-9. To save the current RT setup, in the Create Repair Types window click the Save button.

Part 4. Assign an ABB Curve to Parameters and to a Repair Type

In this procedure you assign an ABB curve to a set of Raster Parameters and to a Repair Type.


To assign an ABB curve to Parameters and to a Repair Type
Select the Create Repair Type window from main icon menu
Click on the repair name
Click on the Params button
Select profile name from Curve Data Base Manager window
Click on the Assign button
Click on the Save button
Click on the Close button
In the Create Repair Types window, click on the Save button

Assigning ABB: Action Diagram

4-1. Call up the Create Repair Type window by clicking on RT in the main icon menu.

The Create Repair Type window appears.

4-2. In the Create Repair Type window, click on the repair name, *ABB*, in the menu.

The name is highlighted and appears in the Name box.

4-3. Click on the Params button.

The Raster Parameters popup appears.

4-4. In the Curve Data Base Manager window, select histogram *RST.*

RST is highlighted in the menu, and appears in the Curve Name box.

4-5. To assign *RST* to the parameters of the Repair Type, in the Curve Data Base Manager window click the Assign button.

In the Raster Parameters popup, the name of the image intensity histogram is placed in the Standard Curve File box.

4-6. To save the ABB parameters of the repair type, in the Create Repair Type window click on the Save button and then click the Close button.

4-7. To save the current RT setup, in the Create Repair Types window click on the Save button.

Section 8: Fluids Regulation

- 08-01 Fluids Regulator Pressure Check
- 08-02 Vibration Isolator Balance Adjustment

Micrion

Service Procedure No.: **08-01**
Service Procedure Title: **Fluids Regulator Pressure Check**
Applicable Systems: **8000, Micrion 9800 FlipChip, MicroMill HT**
Frequency of Service: **Monthly**

Introduction

This procedure describes how to measure the air pressure supplied to the isolation columns and the pneumatically-operated valves. It also describes how to measure the nitrogen gas pressure used for venting the system to atmosphere. These pressures are indicated on gauges on the fluids regulator panel shown in Figures 1 and 2.

- The DN_2 (dry nitrogen) pressure gauge on the fluids regulator panel should read between 3 and 5 psi when the system is under vacuum (V3 closed).
- The air pressure gauge on the fluids regulator panel should read 70 psi. The gate valve (V6) may not operate properly at pressures below 70 psi.
- The isolation system air pressure should read 10 psi higher than the front isolator's gauge (on the same side) with the chamber floating 3/8" above the process module table (see Service Procedure 08-02).

NOTICE

Per paragraph 11.1 of Safety Guidelines for Semiconductor Manufacturing Equipment (S2-93), this procedure is a Type 3 task. Specifically: "Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are less than 30 volts RMS, 42.2 volts peak, 240 volt-amps, and 20 Joules."

Part 1. Procedure

1-1. Before checking the nitrogen pressure, make sure the Nitrogen valve (V5) is closed by entering the *vacchat* command:

```
clv5
```

WARNING

Dangerously high voltages are present in the process module while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and automatic procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supply**.**

At the rear and right side of the process module are the fluids regulator panel, the isolation system primary pressure gauge, and the pressure gauge for the front isolator. See Figure 1.

1-2. Read the right-hand gauge (labeled *DN_2 Vent*) on the fluids regulator panel (see Figure 2) and record the pressure in the system logbook.

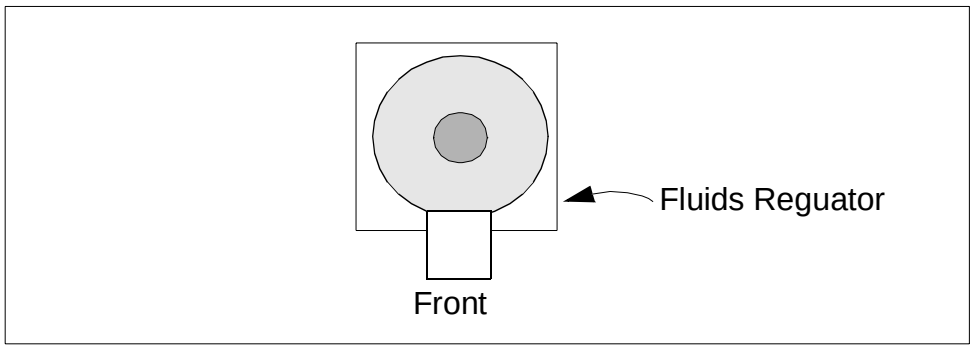


Figure 1. Location of Fluids Regulator Panel: Top View

The DN_2 (dry nitrogen) pressure gauge on the fluids regulator panel should read between 3 and 5 psi when the system is under vacuum (V3 closed).

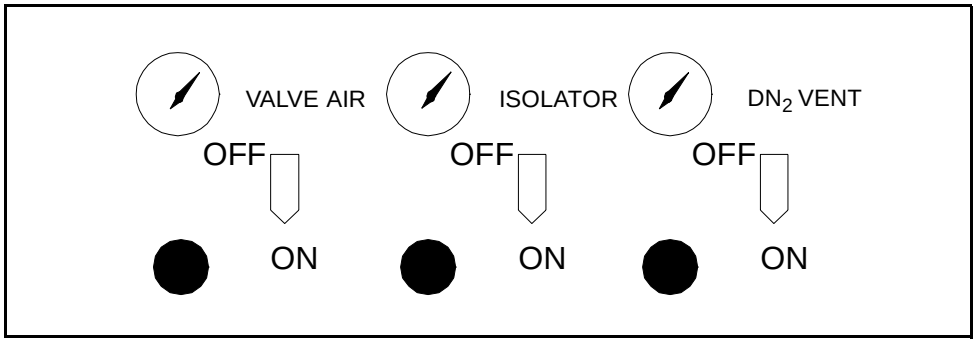


Figure 2. Fluid Regulator Switches: Side View

The need to make an adjustment to the DN_2 supply pressure indicates a change that you should investigate. Consider the following:

- The facility's nitrogen supply pressure should be between 15 and 40 psi. The lower the pressure, the longer it takes to vent the FIB system.
- Leaks in the nitrogen lines or faults in the fluids regulator can affect the gauge pressure and the venting time.

1-3. On the fluids regulator panel, read the *Valve Air* gauge and record the pressure in the system logbook (see Service Procedure 05-01 for logging).

If the pressure is not at 70 psi (or there is improper pneumatic valve operation that you can attribute to low air pressure) you may be able to adjust the pressure using the pressure regulator control on the fluids regulator panel.

The air pressure gauge on the fluids regulator panel should read 70 psi. The gate valve (V6) may not operate properly at pressures below 70 psi.

As in the case of the nitrogen pressure, the need to make an adjustment indicates a change that you should investigate. Consider the following:

- The facility compressed air input pressure should be 80 to 100 psi.
- A pneumatic component (regulator, pneumatic line or connection, valve, etc.) may have failed or is beginning to fail.

1-4. The gauge labeled *Isolator Air* is in the middle of the fluids regulator panel.

The isolation system air pressure should read 10 psi higher than the front isolator’s gauge (on the same side) with the chamber floating 3/8” above the process module table (see Service Procedure 08-02).

Record the primary gauge pressure reading in the system logbook. If the gauge pressure is less than 70 psi, go to Service Procedure 08-02 for Vibration Isolator balance.

Micron

Service Procedure No.: **08-02**
Service Procedure Title: **Vibration Isolator Balance Adjustment**
Applicable Systems: **8000, Micron 9800 FlipChip, MicroMill HT**
Frequency of Service: **At installation and setup; as needed**

Introduction

Three vibration isolators dampen the vibrations traveling from the floor through the process module to the stage. Moving the system can cause the vibration isolators to become unbalanced, as can the natural wear of the foam pads. The following procedure is used in the factory for balancing the vibration isolators.

Materials and Tools Required

These procedures require the use of the following tools:

- 3/8" (9.5 mm) spacer (You can use the box end of a 5/8" box wrench as a 3/8" spacer)
- Level (6-9" long)

WARNING

Per paragraph 11.1 of *Safety Guidelines for Semiconductor Manufacturing Equipment* (S2-93), this procedure is a Type 3 task. Specifically: "Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are less than 30 volts RMS, 42.2 volts peak, 240 volt-amps, and 20 Joules."

As shown in Fig. 1, three vibration isolators share the weight of the workchamber.

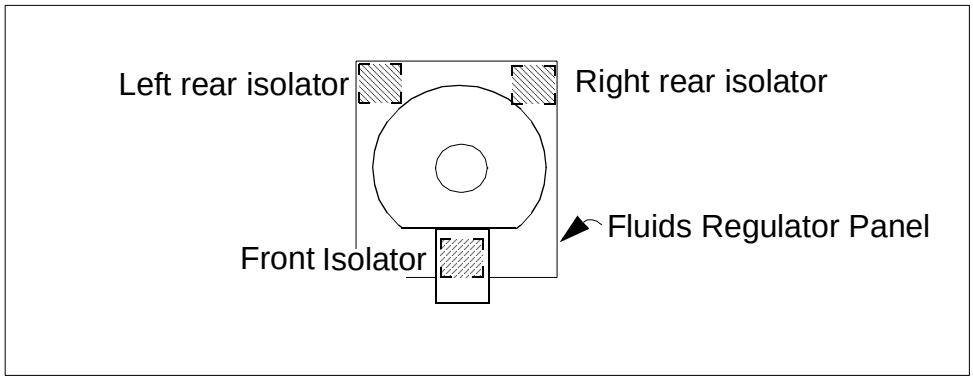


Figure 1. Top View: Process Module with Vibration Isolators

A vibration isolator consists of the following:

- An air source
- An air gauge and associated parts

Figure 2 illustrates the air hose connections under the process module.

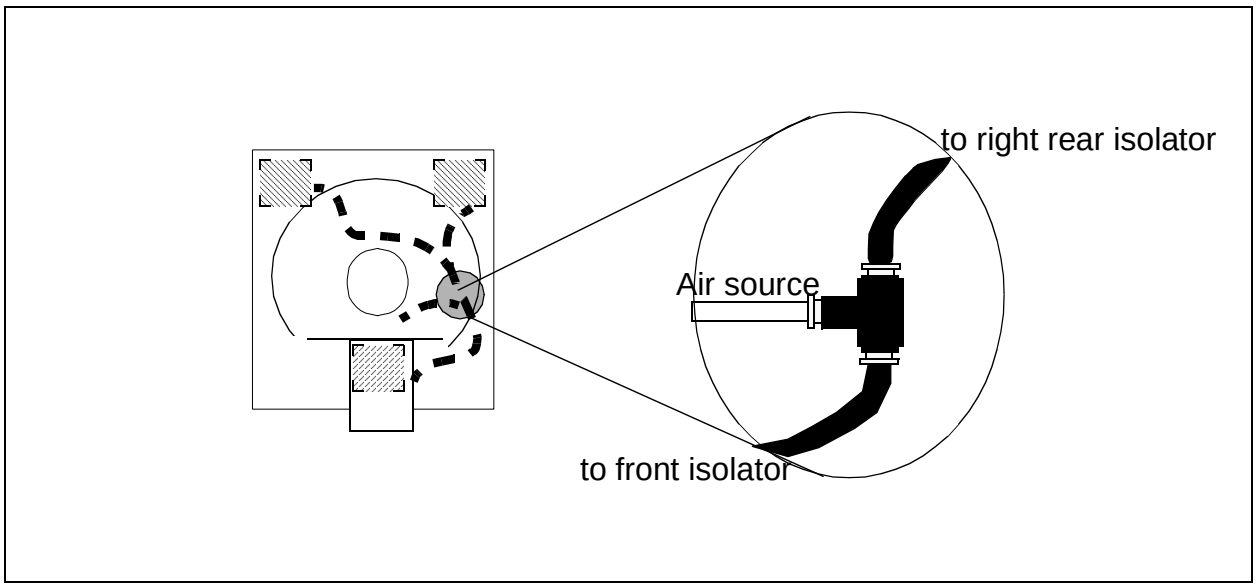
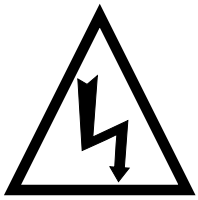


Figure 2. Air hose connections under the workchamber

Part 1. Powering Down the System

Before performing the tasks described in this procedure, you should power down the high voltages to the column; see Service Procedure 01-02.

WARNING



Dangerously high voltages are present in the process module while the FIB column is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and automatic procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

Part 2. Turning On the Isolator Air

On the Fluid Regulator, **turn on the Isolator switch**. See Figure 3.

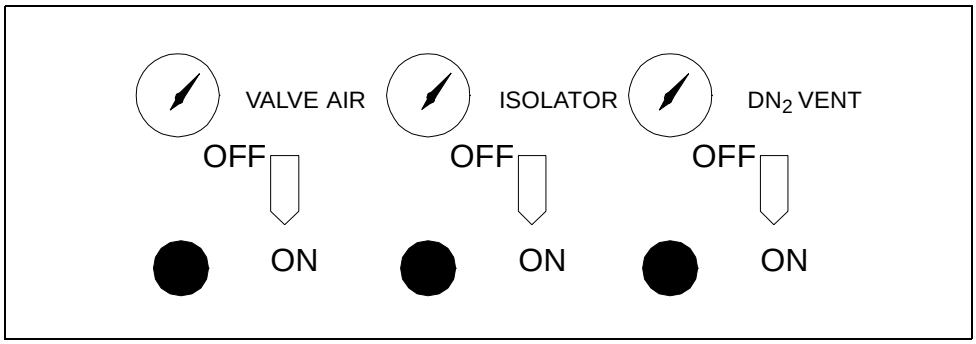


Figure 3. Fluid Regulator Switches

2-1. Set the **Isolator gauge** to 60 psi.

Part 3. Balancing the Vibration Isolators

Balance is achieved when the three isolators show the following characteristics:

- A 1/4" to 3/8" (6.7 mm to 9.5 mm) gap exists between the pad and the collar of each piston
- The lever arms on the isolator air valves are level

Work with one vibration isolator at a time. Set the 3/8" (9.5 mm) gap, then level the lever arm.

Every time you change the position of a lever arm, you must check the 3/8" (9.5 mm) gap.

You can proceed with the vibration isolators in any order. In this procedure, we start with the isolator at the right rear.

3-1. **At a rear isolator,** such as shown in Figure 4**,** turn the pressurizing screw clockwise until the gauge reads 35 psi. Repeat for the other rear isolator. Within 30 seconds, the process module table will stabilize.

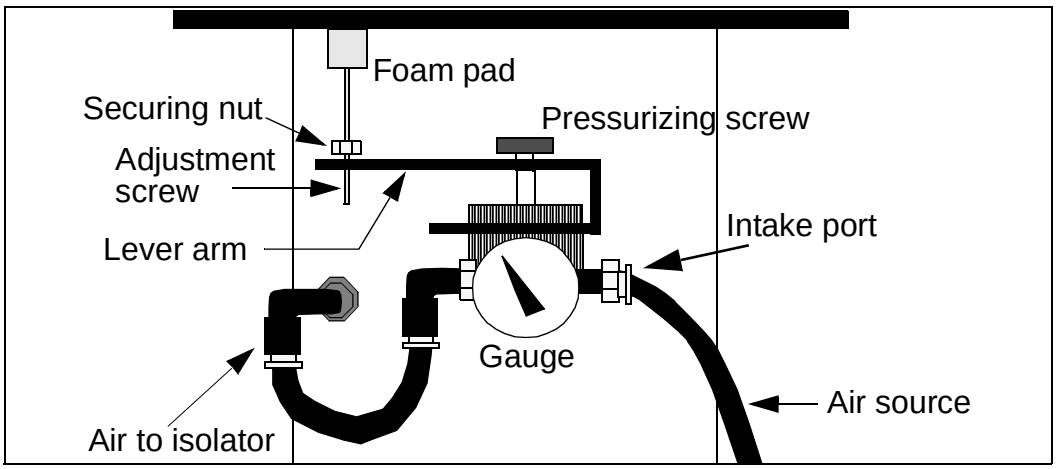


Figure 4. Side View: Vibration Isolator

3-2. Try the **spacer** between the pad and the piston collar. Turn the pressurizing screw at the secondary air regulator to increase or decrease the air pressure until the spacer can fit snugly.

3-3. Once the gap has been established, **check the lever arm** to see if it is level. If necessary, turn the adjustment screw to level the lever arm.

3-4. Next, adjust the pressurizing screw to regain the spacing. Check the lever arm again. When the gap is correct and the lever arm is level, lightly tighten the securing nut.

3-5. **Repeat steps 3-1 through 3-4** at the other two isolators.

3-6. When the gaps are set, **note the highest air** pressure at the valve gauges.

3-7. To achieve the optimum damping control, adjust the air pressure in the Fluid Regulator to 10 psi more than the value noted in the previous step (2-7).

Section 9: Computer, Software

- 09-01 Archiving/Restoring Micrion Data Files
- 09-02 Setting Time and Date on IBM RS6000 Computers
- 09-03 Using the *Vacchat* Program
- 09-04 Using the Micrion Constants Editor
- 09-05 Upgrading to RS6000 Computer
- 09-06 Configuring AIX for a Network Printer

Micrion

Service Procedure No.: **09-01**
Service Procedure Title: **Archiving/Restoring Files using *arctool***
Applicable Systems: **All**
Frequency of Service: **Monthly**

Introduction

One of the most important preventive maintenance procedures is backing up or archiving the files in the `/user/micrion/fib/data` directory.

A program called *arctool* is available on the system to automatically archive and restore critical files, including Constants, MDDL, Labels, Lens Tables, Locks, Logs, Mif Files, Repair Types, Stage Maps, Wafer Maps, and Tiff Files. In addition, you can define your own category of files to archive and/or restore.

You can be in any directory and use arctool to archive or restore a file of the types listed above.

Materials Required

- 3.5" diskettes
- *arctool* program

Part 1. Determining the Number of Backup Diskettes

1-1. Log in as “micrion”.

1-2. Determine the number of archive diskettes required as follows:

- Go to the directory you are backing up:
  `cd /usr/micrion/fib`
- Determine the size of this directory structure:
  `du -k data`

  This command returns the size of all the files and subdirectories under the `data` directory in kbytes, and also returns the total size of the `data` directory structure in the last line, as shown in Figure1.

```
fib43(micrion) 10 =>du -k data
28      data/sys_labels
76      data/labels
660     data/help
13256   data/tiff
60      data/asm
184     data/repair_types/relconst
184     data/repair_types/saveconst
548     data/repair_types
404     data/MDDL
112     data/lenstab
4       data/log/MDDL
12      data/log/egun
12      data/log/mcp
12      data/log/source
48      data/log
84      data/lenstab.25nm
84      data/lenstabold
4       data/stage_maps
40      data/locks
8       data/wafer_maps
132     data/mif/mif
12      data/mif/mifout
4       data/mif/class
4       data/mif/res
4       data/mif/sem
4       data/mif/kla
4       data/mif/tnc
4       data/mif/njs
172     data/mif
15732   data
fib43(micrion) 11 =>
```

Figure 1. Output of the `du -k data` Command.

1-3. If you are using 3.5" (1.44 MBytes) diskettes to back up the files, divide the size of the directory (in kBytes) by the capacity of the diskette (1,440 kB) to determine the number of 3.5" diskettes you need.

If the size is 1816 kB, divide by 1440 kB to find the number of 3.5" diskettes required:

$$\frac{1816 kbq}{\frac{1440 kb}{disk}} = 1.26 disks$$

or 2 diskettes.

If you are using 3.5" diskettes with 2.88 MB capacity to back up the files, divide the size of the directory (in kB) by the capacity of the diskette (2,880 kB) to determine the number of diskettes you need (1 diskette).

1-4. If more than one diskette is required, label the diskettes with the date of the backup, the machine you are backing up, and the numbering sequence of the diskettes (for example, 1 of 10, 2 of 10, etc.).

Part 2. Gaining Access to *arctool*

2-1. In a terminal window, type

```
arctool
```

The Micrion Archive Tool window appears.

Part 3. Formatting Diskettes

3-1. To format diskettes, select Format in the Micrion Archive Tool window.

Part 4. Archiving/Restoring Files

To see a full explanation of the tools and the procedure used to archive and to restore files, select *Hints* from the bottom of the Micrion Archive Tool window.

Micron

Service Procedure No.: **09-02**
Service Procedure Title: **Setting Time and Date on IBM RS6000 Computers**
Applicable Systems: **All**
Frequency of Service: **As Needed**

Introduction

This procedure describes how to set the system date, time, and time zone on an RS6000 based workstation using the System Management Interface Tool (SMIT). You must know the root password for the system that you are working on.

Part 1. Set Date and Time

1. In an xterm window, change to super-user and type the root password when prompted:

```
su ↵
root's Password:
```

You are now logged in as root.

2. Bring up the SMIT program by entering the `smit` command.

3. In the SMIT main window, select the System Environments option.

4. In the System Environments window, select *Change/Show Date, Time,* and *Time Zone*.

5. SMIT asks if your time zone is in Daylight Saving Time. Answer yes or no.

6. From the list of time zones, click the correct time zone for your location.

7. Edit the date, time and other parameters in the fields displayed, and click on the *Do* button.

8. SMIT displays a message:

```
Now exit SMIT and log out and then log back in so that any changes to
date, time, and time zone will be reflected in your current session.
```

Click the *Done* button and then select *Exit*.

9. You must quit the FIB application program and log out of the system for the changes you have made to take effect.

a. Quit the application.

b. Click on Quit & Exit in the Process Watcher popup.

c. At the command prompt, restart the X windows program by typing:

```
xinit
```

Micrion

Service Procedure No.: **09-03**
Service Procedure Title: **Using the *Vacchat* Program**
Applicable Systems: **All**
Frequency of Service: **As Needed**

Introduction

The *vacchat* program provides a control interface to the vacuum control system. You may use *vacchat* to obtain information on the status of valves, pumps, and vacuum level readings. You can open and close valves, turn pumps on and off, vent to atmosphere, and pump down to vacuum.

Starting Vacchat

The *vacchat* program can be started in two different ways.

- By selecting the *Vacchat* entry from the Process Watcher menu, or
- By starting *vacchat* in an *xterm* window by typing

```
vacchat ↵
```

A screen similar to that shown in Figure 1 is displayed while *vacchat* initializes.

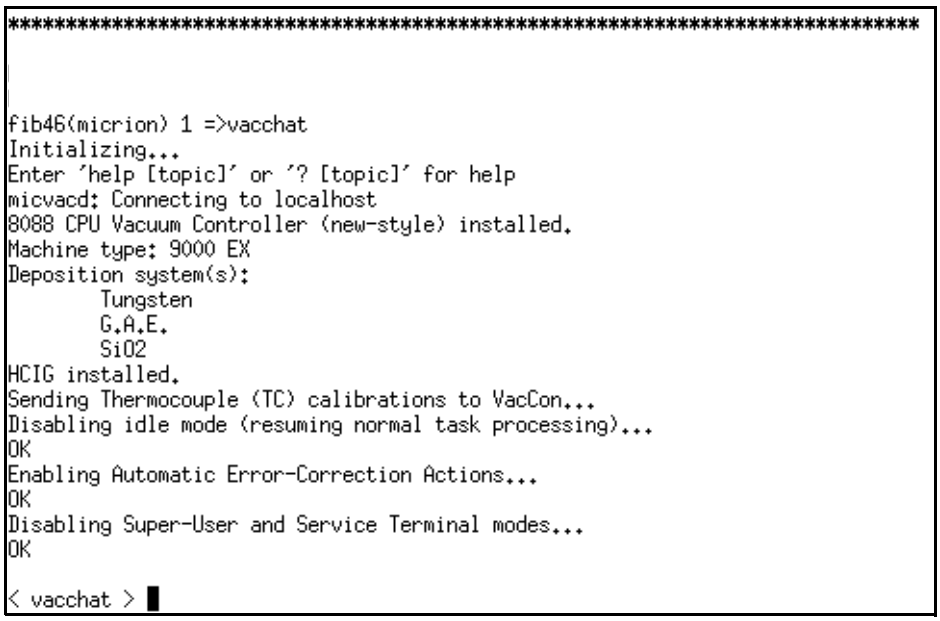


Figure 1. Vacchat Start-up Screen.

Obtaining Vacchat Help

While you are in the *vacchat* shell, display the *vacchat* Help session, by typing:

```
help
```

or

```
?
```

You can also display help on specific topics by typing:

```
help [topic]
```

where `[topic]` is the name of the command or process you are requesting help for; `[topic]` must be spelled correctly and have the correct case (upper or lower). If the program cannot match the specific topic you requested, it will run the general help session.

The *vacchat* help session is displayed as shown in Figure 2.

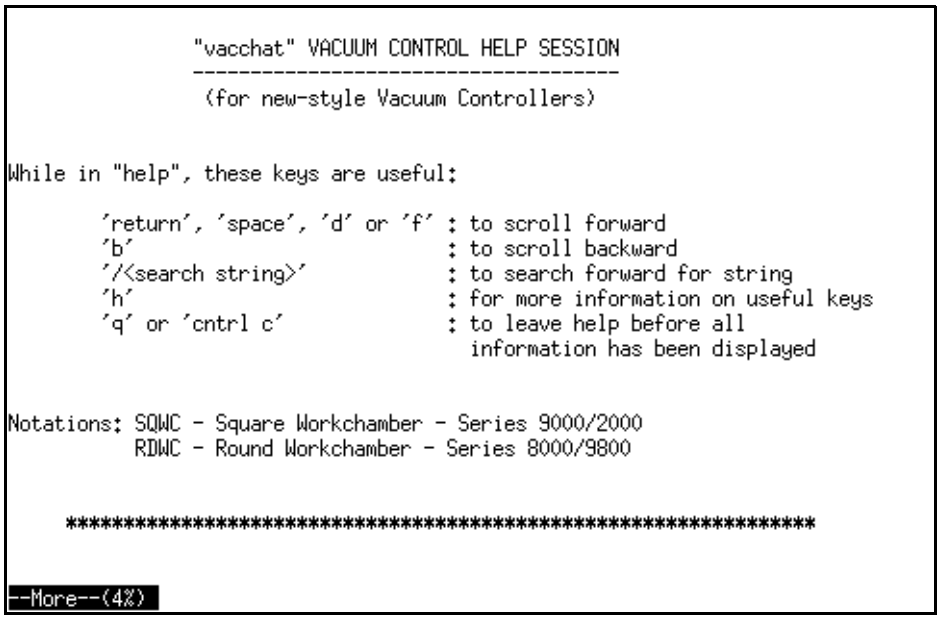

"vacchat" VACUUM CONTROL HELP SESSION
(for new-style Vacuum Controllers)
While in "help", these keys are useful:
'return', 'space', 'd' or 'f' : to scroll forward
'b' : to scroll backward
'/<search string>' : to search forward for string
'h' : for more information on useful keys
'q' or 'cntrl c' : to leave help before all information has been displayed
Notations: SQWC - Square Workchamber - Series 9000/2000
RDWC - Round Workchamber - Series 8000/9800
--More--(4%)

Figure 2. Vacchat Help Session Instruction Screen

The help session provides you with all the commands and their functions available in *vacchat.*

Micrion

Service Procedure No.: **09-04**
Service Procedure Title: **Using the Micrion Constants Editor**
Applicable Systems: **All**
Frequency of Service: **As needed**

Introduction

The Micrion Constants Editor is used for editing parameters stored in program constants files. The Constants Editor changes only the *value* of parameters in a constants file. It cannot be used for adding or deleting the parameters themselves, nor can it be used for creating or deleting constants files.

A constants file consists of a series of lines of ASCII text. Lines beginning with the asterisk symbol (`*`) are *comments* ignored by the FIB application software. Each non-comment line is a parameter entry consisting of three fields separated by one or more spaces:

Parameter name —leftmost field; a character string describing the parameter entry.

Index — middle field; distinguishes among two or more instances of the same parameter name. For example, in the Aperture.M constants file, the Aperture_size parameter appears once for each limiting aperture. For the first (or only) instance of a parameter, the index field is set to 0.

Parameter value —rightmost field, the only part of the parameter entry that you can change using the Constants Editor.

Start the Editor

The Constants Editor is accessible through the Micrion Process Watcher popup dialog box, or by typing the command `cs_edit` in an xterm window.

Select a File for Editing

Click the *File* button in the Constants Editor popup to get the pulldown menu shown in Figure 1. On the pulldown menu, click the *Constants Files* selection to get the Open File popup.

The only file names that appear in the Open File popup are those that fit the general pathname in the *Filter* field. By default, this pathname is "/usr/micrion/fib/data/*.M". All constants file names end with "`.M`", as in: `Apertures.M`, `User.M`, etc.

When you select a file, the Constants Editor popup shows the file name and the contents of the file in the display area at the bottom of the popup. To select a file for editing, double-click the file name in the Files list, or click its name and then click the *Open* button.

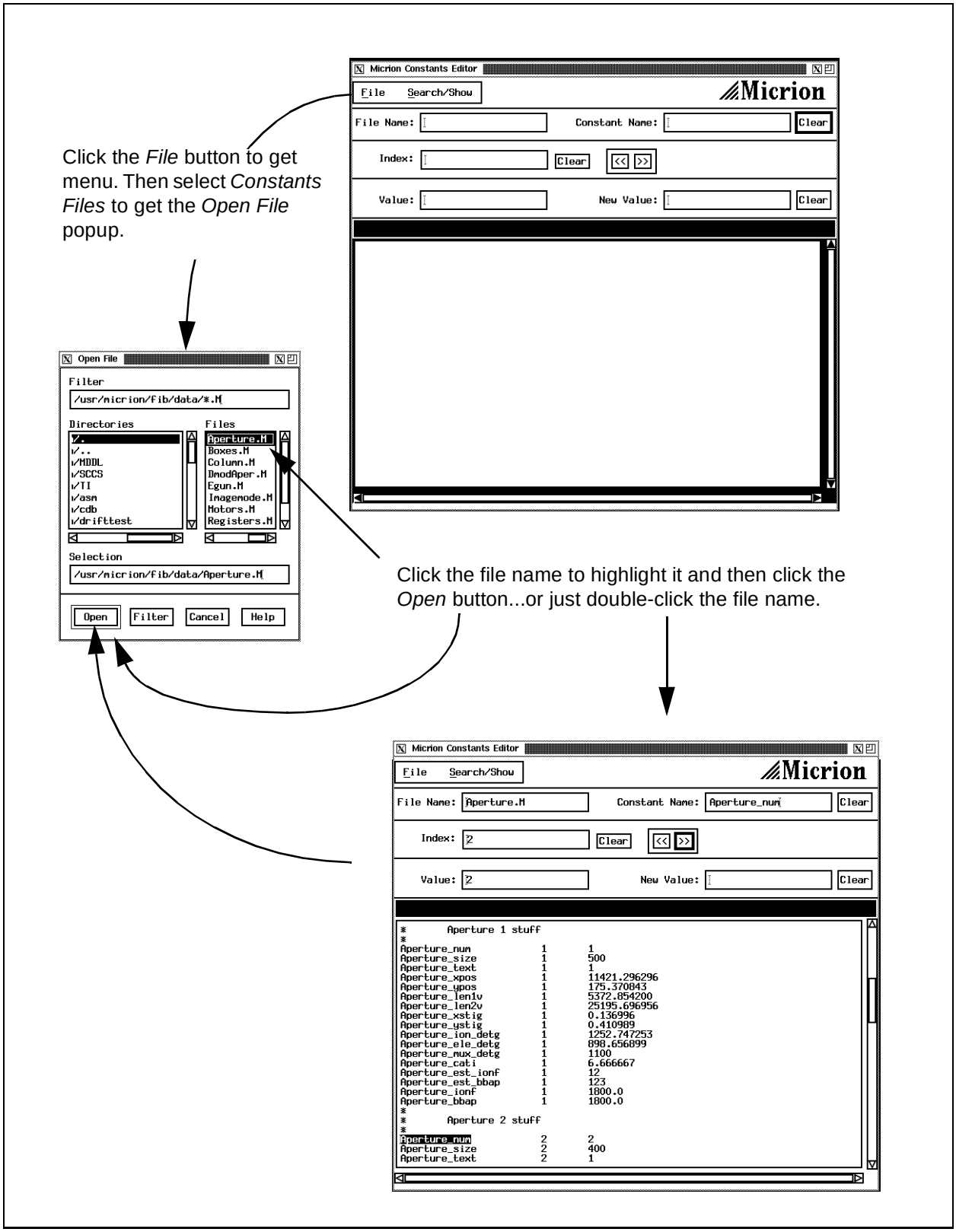


Figure 1. File Selection with the Constants File Editor.

Edit a File

The Constants Editor popup has two parts: the lower part is a window listing the contents of the selected file; the upper part contains the editing controls.

To edit a parameter value, proceed as follows:

1. Scroll through the file until you see the name of the parameter whose value you want to change.
2. Double-click the parameter name (with the left mouse button) to highlight it.
3. If the *Constant Name* field in the popup is not empty, click its *Clear* button to clear it.
4. Move the mouse pointer into the *Constant Name* entry field and click the *middle* mouse button. The selected parameter name then becomes copied to the field.
5. Press the *Enter* key (↵) on the keyboard to complete the entry—*this is required*. The Index field then automatically defaults to 0, and the current value for the parameter name and index 0 appears in the *Value* field.
6. Click the left or right arrow button in the *Index* field to select the index for the particular combination of parameter name and index whose value you want to change.

   Click the *New Value* field to select it. Use the *Clear* button if the field is not already clear, and then type the new value with the keyboard. Press the Enter key (↵) on the keyboard to complete the entry. When the following warning appears:

   ```
   Warning: FILE WILL BE CHANGED
   ```

   ...click *OK* or *Cancel* as appropriate.

To be certain that any changes you make take effect, **you must exit the application program**. Quit the X Window interface, and then restart. Click the *Quit & Exit* button in the Micrion Process Watcher to exit the FIB application program and the X window system.

After exiting, restart the X window system and Microsurgery by typing:

```
xinit ↵
```

Search/Show

The *Search/Show* button in the Constants Editor popup provides the following selections:

- *Next Constant:* highlights the next sequential instance of the parameter name that has been entered in the Constant Name field.
- *Show All:* highlights all instances of the parameter name entered in the Constant Name field.
- *Clear All:* clears any highlighting.

Quitting the Editor

To exit from the Constants Editor, click the *File* cascade button in the upper left corner of the popup to get the pulldown menu, and click on the *Quit Editor* selection.

Micrion

Service Procedure No.: **09-05**
Service Procedure Title: **Upgrading to RS6000 Computer**
Applicable Systems: **All**
Frequency of Service: **As needed**

Introduction

This procedure applies to all upgrades from i486 to IBM RS6000 computer. The new RlSC computer should come pre-loaded with the operating system and the latest Micrion software release. It will be necessary to transfer certain data files from the current computer to the new one.

Materials Required

- Adaptor cable - 235090 (25 pin to 9 pin)
- IBM RS6000 Computer - 100-006762 (Model 34H) or 100-006763 (Model 370)
- Bit 3 444-202 Multibus Card - 240-000125B
- Raster Generator Upgrade - 100-010750 [1]
- Service Procedure 09-01 - Archive/Restore Data Files - i486 and RS6000 Systems
- 3.5" or 5.25" Diskettes
- Latest EPROM

NOTICE

Per paragraph 11.1 of *Safety Guidelines for Semiconductor Manufacturing Equipment* (S2-93), this procedure is a Type 3 task. Specifically: "Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are less than 30 volts RMS, 42.2 volts peak, 240 volt-amps, and 20 Joules."

[1] Only necessary on systems that are not currently equipped with a Raster Gen (150-001110) and a Signal Acquire (150-001381 REV C)

Part 1. Backing Up Data Files

1-1. Back up the `/usr/micrion/fib/data` directory as described in Service Procedure 09-01. It will be necessary for you to restore these files later on the new computer.

1-2. Saving tiff files requires a 1.44Mb diskette for each file.

To save the tiff files on 486, type the command:

```
cd /usr/micrion/fib/data/tiff
flopon -t tar 'filename'
```

Part 2. System Preparation

Configure the Chemical Sources in "Safe" Mode

Before performing the tasks described in this procedure, you must put the chemical sources in a "safe" mode; see Service Procedure 02-01.

WARNING

Do not proceed until the chemical sources are secure. The chemical reservoirs in FIB systems contain hazardous materials. Labels affixed to the exterior of a chemical cabinet identify the chemical(s) contained inside. If a chemical source is not in its "safest" state, as described in **Service Procedure 02-01**, it is possible for a combination of component failures to release the chemical(s) through a cabinet's delivery line, a roughing line, a purging line, or from the tungsten reservoir into the workchamber. Do not open the workchamber, or disassemble any part of the vacuum pumping system, or detach any gas line from any chemical cabinet until you are sure that every chemical source attached to the FIB system is in its "safest" state.

Power Down and Vent the System

Before performing the tasks described in this procedure, you must power down and vent the system; see Service Procedure 01-02.

Part 3. Changing the hardware

3-1. Before proceeding, see Service Procedure 01-02, Power Down, Reset, and Vent.

WARNING

Dangerously high voltages are present in the process module while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and auto procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

3-2. Disconnect and remove the existing Bit 3 board and cable from the SysCon.

3-3. If the SysCon is equipped with a Multiscan Board (150-000293), remove this board and replace it with the Raster Generator board (150-001110).

3-4. Verify that the Signal Acquisition board (150-001381) is at least Rev C.

3-5. Remove the cable from P1109 on the rear of the VacCon module.

3-6. Install adaptor cable no. 235090 at rear of Risc station.

3-7. Remove the video cable.

3-8. Remove the cable from connector J2220 on rear of SysCon.

3-9. Remove the Knob Panel Interface Board (150-000841). You must change the interrupt jumper located on the lower left corner of the PC board from INT2 to INT5.

3-10. Refer to Fig. 1 and install the new parts as shown.

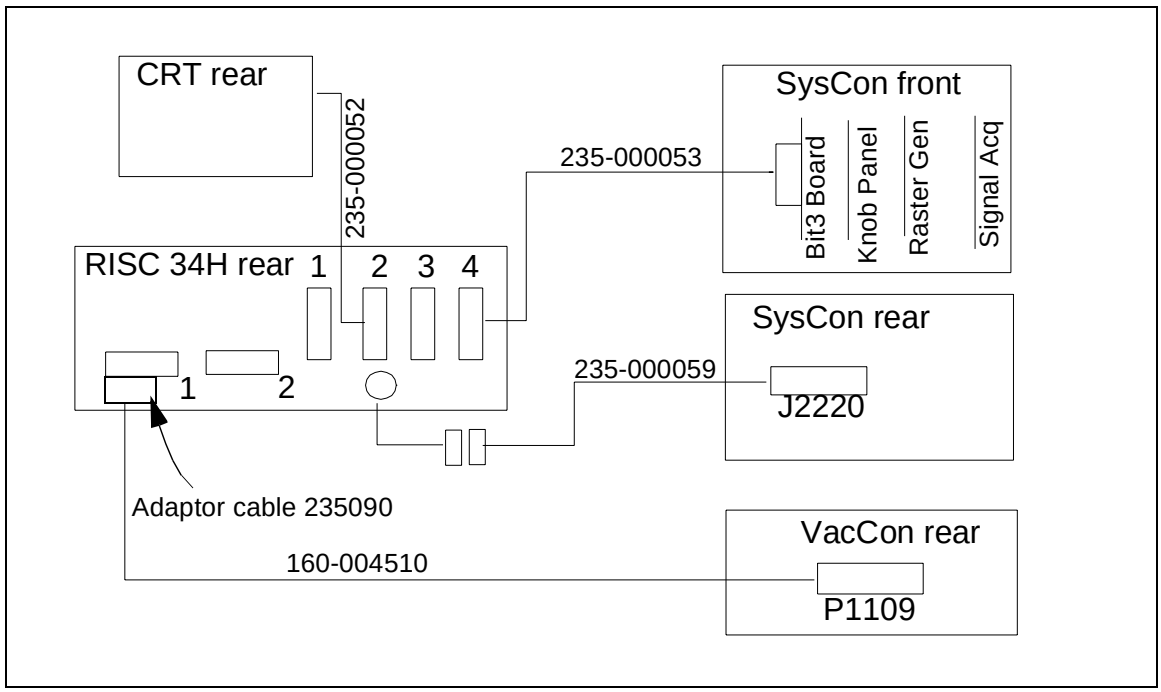


Figure 1. RS6000 Upgrade Block Diagram

3-11. Reconnect P1109 on the rear of the VacCon; reconnect the video cable, and reconnect J2220 on the rear of the SysCon.

3-12. Restore power to the Syscon.

3-13. Restore power to the computer and wait for the bootstrap to complete.

Before using the system for normal operation, you must restore the data files saved from the 486.

Part 4. Restoring Data Files

4-1. Restore `/usr/micrion/fib/data` as described in Service Procedure 09-01.

4-2. Restore tiff files; each tiff file will be on a separate 1.44Mb diskette.

```
cd /usr/micrion/fib/data
flopoff <filename>
```

Repeat the flopoff command for each diskette.

4-3. At this point the system should be operational. If for some reason the software that was preloaded on the upgrade computer was an earlier revision than what you were running on the i486 system, contact Micrion Product Support.

Micrion

Service Procedure No.: **09-06**
Service Procedure Title: **Configuring AIX for a Network Printer**
Applicable Systems: **All**
Frequency of Service: **As Needed**

Introduction

This procedure explains how to configure the AIX operating system on the system computer to allow TIFF files to be sent to the optional *Codonix* network printer.

Use part 1 of this procedure if the system computer and the printer are connected through the customer's Ethernet local area network (LAN). You will have to obtain the Internet Protocol (IP) address to be assigned to the printer from the site's network administrator.

Use part 2 of this procedure if the printer is connected directly to the system computer (in effect, creating a two-host network).

In both cases, it is assumed that the electrical connections have already been made.

This procedure consists of creating or modifying the following five files on the system computer:

```
/usr/micrion/fib/bin/tiff_print
/usr/micrion/.ftp_macro
/usr/micrion/.netrc
/etc/hosts
/etc/hosts.equiv
```

You will also have to refer to the operation manual provided by the printer manufacturer for information about how to enter the printer's Internet Protocol (IP) address through the printer's control panel.

You should be logged into the FIB system computer as *micrion*.

Part 1. Configuring for the Site's LAN

1-1. Create and edit the `tiff_print` file:

A copy of a `tiff_print` file is included in the application software release. It is named `tiff_print.new` (to prevent the installation of software releases from overwriting an existing copy of the file). When installing the network printer for the first time, make a renamed copy of this file as follows:

```
cd /usr/micrion/fib/bin ↵
cp tiff_print.new tiff_print ↵
```

The tiff_print file is the script (or command) for sending files to the printer, and it includes the printer's network host name. The default host name is cnp. We suggest that you change the name to np1600 or to whatever name the local network administration personnel prefer. To do this, open the file with the vi editor, find the line that looks like:

```
PRINTER_NAME=cnp
```

and change cnp to the new host name for the printer. Thus, for example:

```
PRINTER_NAME=np1600
```

1-2. Create the .ftp_macro file:

Use the cat command to create the .ftp_macro file as follows. Note that you will not get a prompt while the cat function is operating, and that the cat function is terminated by pressing the ctrl-d key combination. Enter:

```
cd /usr/micrion ↵
cat > .ftp_macro ↵
binary ↵
put tmp_tiff ↵
quit ↵
{crl-d}
```

1-3. Create the .netrc file:

Use the cat command to create the .netrc file:

```
cat > .netrc ↵
machine <printer_name> login micrion password 2 ↵
{ctrl-d}
```

where <printer_name> is the printer's host name. It must be the host name that you changed cnp to (for example, np1600).

1-4. Use the chmod command to set the access permissions for the .netrc file:

```
su ↵
{enter the root password}
chmod 600 .netrc ↵
```

1-5. Edit the hosts file:

The /etc/hosts file on the FIB system computer contains lines that associate IP addresses with alphanumeric host names. Open the file with the vi editor and add a line of the form:

```
<ip_address> <printer_name>
```

where <ip_address> is the IP address assigned to the printer by the local network administration personnel, and <printer_name> is the printer host name that you substituted for cnp in the tiff_print file. You must also install that IP address in the printer through the printer's control panel (according to the instructions given in the operation manual supplied by the printer manufacturer).

1-6. Edit the `hosts.equiv` file:

The `/etc/hosts.equiv` file is a list of host names, and the host name for the printer must be included. Open the file with the `vi` editor and add a line with the host name for the printer (for example, `np1600`).

1-7. Terminate "root" status:

```
exit ↵
```

1-8. Test the installation by entering:

```
cd /usr/micrion/fib/data/tiff ↵
tiff_print <filename> ↵
```

where `<filename>` is the name of a TIFF file to be printed.

Part 2. Configuring for Direct Connection

2-1. Create the `tiff_print` file:

A copy of a `tiff_print` file is included in the application software release. It is named `tiff_print.new` (to prevent the installation of software releases from overwriting an existing copy of the file). When installing the network printer for the first time, make a renamed copy of this file as follows:

```
cd /usr/micrion/fib/bin ↵
cp tiff_print.new tiff_print ↵
```

The `tiff_print` file is the script (or command) for sending files to the printer, and it includes the printer's host name. The default host name is `cnp`. You can use this default name, in which case it is unnecessary to edit the file.

2-2. Create the `.ftp_macro` file:

Use the `cat` command to create the `.ftp_macro` file as follows. Note that you will not get a prompt while the `cat` function is operating, and that the `cat` function must be terminated by pressing the ctrl-d key combination. Enter:

```
cd /usr/micrion ↵
cat > .ftp_macro ↵
binary ↵
put tmp_tiff ↵
quit ↵
{crl-d}
```

2-3. Create the `.netrc` file:

Use the `cat` command to create the `.netrc` file, and then use the `chmod` command to set its access permissions:

```
cat > .netrc ↵
machine cnp login micrion password 2 ↵
{ctrl-d}
chmod 600 .netrc ↵
```

Note the assumption that the default host name (`cnp`) is being used.

2-4. Get the IP address for the printer:

The `/etc/hosts` file on the FIB system computer contains lines that associate IP addresses with alphanumeric host names. Normally, one of the default entries is:

```
204.176.154.253   cnp
```

Make sure that entry exists by entering:

```
grep cnp /etc/hosts ↵
```

The response should be exactly as shown above. If it is, and if the default host name (`cnp`) is being used, you do not have to make any change to the `hosts` file. If the entry does not exist in the hosts file, open the file with the `vi` editor and add the entry line given above. In either case, you will have to install 204.176.154.253 as the IP address in the printer through the printer's control panel (according to the instructions given in the operation manual supplied by the printer manufacturer).

2-5. Check the `hosts.equiv` file:

The contents of the `/etc/hosts.equiv` file is a list of host names, and the host name for the printer must be included. If the default host name (`cnp`) is being used, verify that it is listed by entering:

```
grep cnp /etc/hosts.equiv ↵
```

If the response is not `cnp`, the entry is not in the file; open the file with the vi editor and add the entry line.

2-6. Test the installation:

You can test the installation by entering:

```
cd /usr/micrion/fib/data/tiff ↵
tiff_print <filename> ↵
```

where <filename> is the name of a TIFF file.

Section 10: Deposition System

- 10-01 Lubricating the Dual Nozzle Lead Screws
- 10-02 Dual Nozzle Replacement and Coarse Alignment
- 10-03 Dual Nozzle Fine Alignment
- 10-04 Funnel Replacement
- 10-05 Funnel Alignment
- 10-06 Verifying Depo Limit Switch Settings
- 10-07 Making Heater and Cooler Board Settings

Micron

Service Procedure No.: **10-01**
Service Procedure Title: **Lubricating the Dual Nozzle Lead Screws**
Applicable Systems: **Micrion 9800 FlipChip**
Frequency of Service: **Semiannually**

Overview of the Lubrication Procedure

In the dual-nozzle assembly, there are four lead screws that require lubrication every six months.

- X lead screw
- Y lead screw
- Two Z lead screws, one on each nozzle subassembly; the left nozzle subassembly is Z1, and the right nozzle subassembly is Z2.

Tools and Materials Required

- *Vacchat* program
- Clean-room gloves
- Braycote white grease, 803 (Micrion p/n 790-000006)
- Lint-free wipe (Kimwipe EX-L or equivalent)

NOTICE

Per paragraph 11.1 of *Safety Guidelines for Semiconductor Manufacturing Equipment* (S2-93), this procedure is a Type 3 task. Specifically: "Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are less than 30 volts RMS, 42.2 volts peak, 240 volt-amps, and 20 Joules."

Part 1. System Preparation

Configure the Chemical Sources in "Safe" Mode

Before performing the tasks described in this procedure, you must put the chemical sources in a "safe" mode; see Service Procedure 02-01.

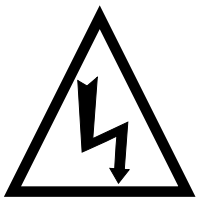
WARNING

Do not proceed until the chemical sources are secure. The chemical reservoirs in FIB systems contain hazardous materials. Labels affixed to the exterior of a chemical cabinet identify the chemical(s) contained inside. If a chemical source is not in its "safest" state, as described in **Service Procedure 02-01**, it is possible for a combination of component failures to release the chemical(s) through a cabinet's delivery line, a roughing line, a purging line, or from a chemical reservoir into the workchamber. Do not open the workchamber, or disassemble any part of the vacuum pumping system, or detach any gas line from any chemical cabinet until you are sure that every chemical source attached to the FIB system is in its "safest" state.

Power Down and Vent the System

Before performing the tasks described in this procedure, you must power down the high voltages and vent the system; see Service Procedure 01-02.

WARNING



Dangerously high voltages are present in the process module while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and automatic procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

Open the Workchamber

Remove the front panels to gain access to the workchamber cover. When the system is completely vented, remove the 1/2" socket-head cap screws and open the workchamber.

Part 2. X Lead Screw

The *x*-drive lead screw drives the entire dual-assembly left to right and right to left. The lead screw is lubricated at the factory. It should be cleaned and re-lubed every six months.

2-1. Remove old and/or excess grease with a lint-free wipe. DO SO VERY GENTLY.

2-2. Apply a syringe-tip of fresh grease where shown in Fig. 1.

2-3. In *vacchat*, type the `JE` command to drive the dual-nozzle assembly slowly to the east (i.e., to the right), and the `JW` command to drive the dual-nozzle assembly slowly west (i.e., to the left) until the *x lead screw* is covered by a thin film of lubricant.

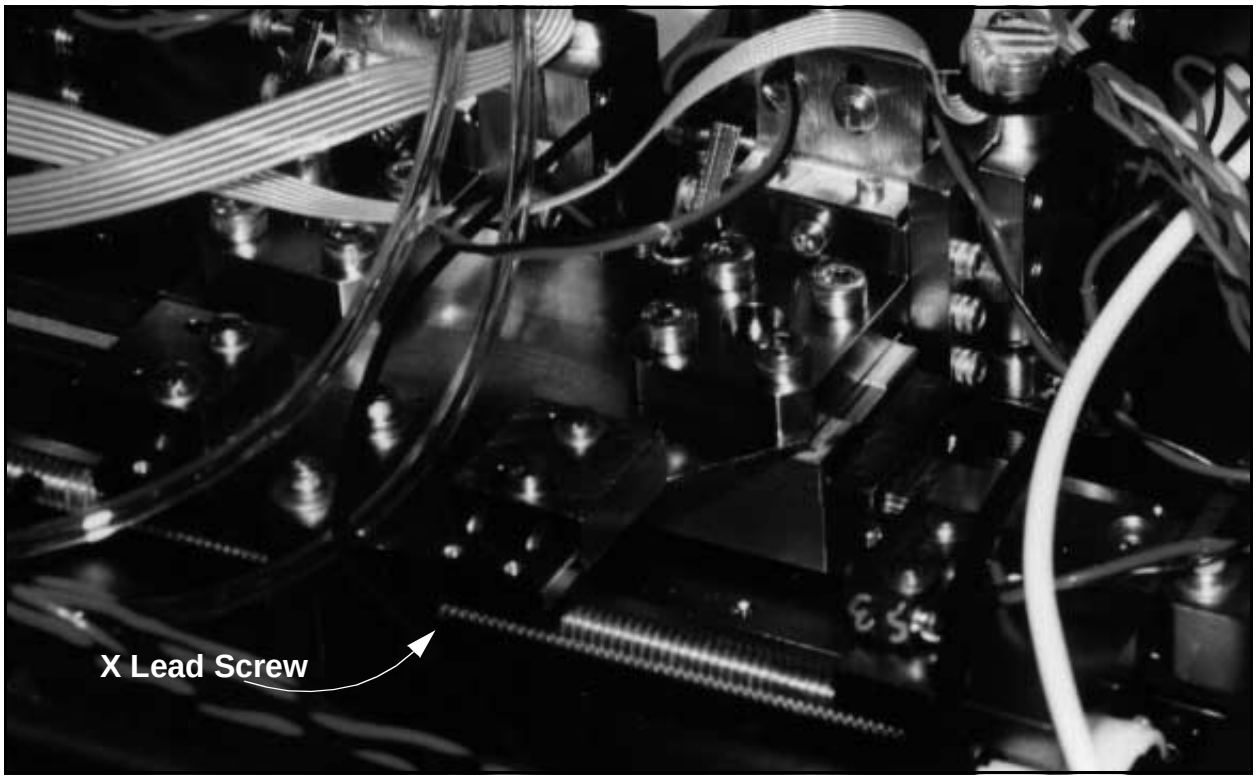


Figure 1. X Lead Screw on the Micrion 9800 FlipChip Mezzanine

Part 3. Y Lead Screw

The *y*-drive lead screw drives the entire dual-assembly forward and back. The lead screw is lubricated at the factory. It should be cleaned and re-lubed every six months.

3-1. Remove old and/or excess grease with a lint-free wipe. DO SO VERY GENTLY.

3-2. Apply a syringe-tip of fresh grease.

3-3. In *vacchat*, type the `JF` command to drive the dual-nozzle assembly slowly forward (i.e., toward the column), and the `JB` command to drive the dual-nozzle assembly slowly back (i.e., toward the front of the chamber) until the *y lead screw* is covered by a thin film of lubricant.

Part 4. Z Lead Screws

Each nozzle subassembly has a z lead screw and z motor. Fig. 2 shows the location of the z lead screw on the two nozzle subassemblies. You can clean and lubricate each of the two z lead screws at the same time. But the nozzle subassemblies can only be driven on the z axis one at a time.

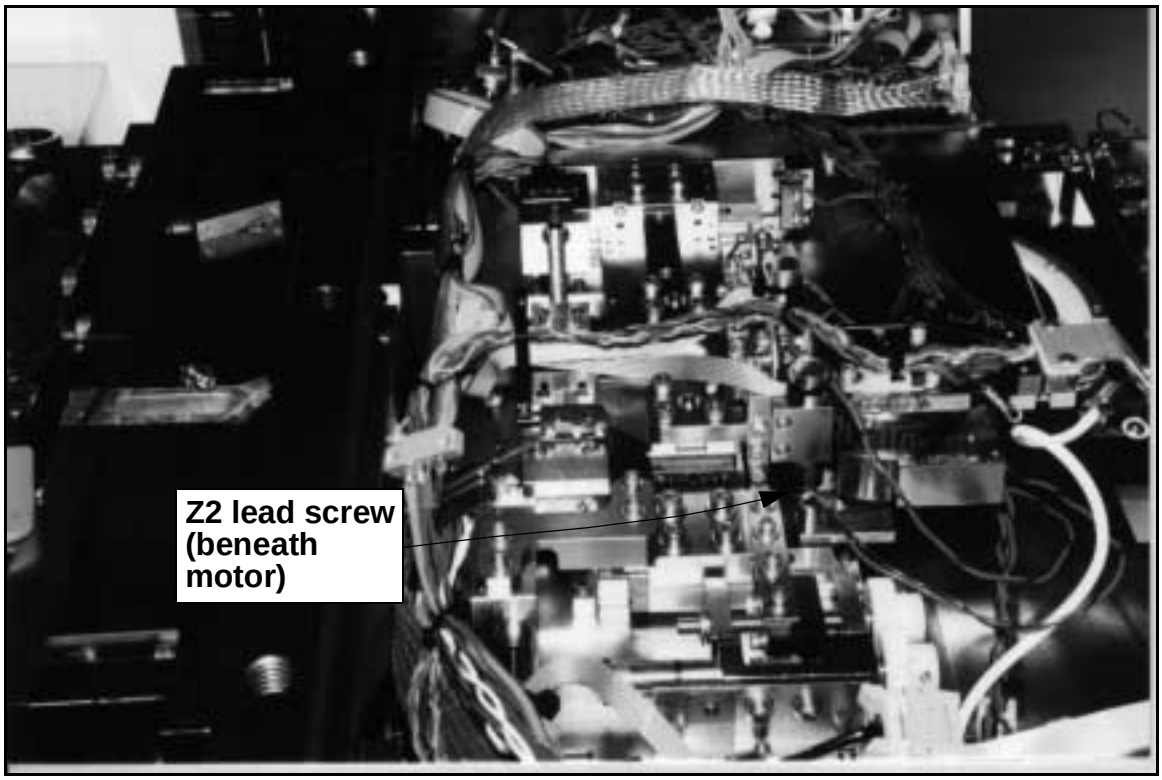


Figure 2. Z Axis Lead Screw for Nozzle Subassembly 2

The procedure begins with the cleaning and lubrication of both lead screws, and ends by driving the left nozzle subassembly (Z1) and then the right nozzle (Z2) subassembly up and down.

See Figure 2 for the location of the two z lead screws. For each of the two nozzle subassemblies, proceed as follows:

4-1. Using the `dpu` command in *vacchat*, select the nozzle menu.

4-2. Select the number of the nozzle.

4-3. Using the `JD` command, drive the nozzle subassembly down to its lower limit.

4-4. From the lead screw, remove old or excess grease with a wipe. DO SO VERY GENTLY.

4-5. Squeeze a small amount of lubricant to the tip of applicator syringe. Extend the syringe tip to just above the brass nut shown in Fig 2 and apply the lubricant.

4-6. Drive the nozzle down slowly and then up again slowly as follows:

```
JD
JU
```

Micron

Service Procedure No.: **10-02**
Service Procedure Title: **Dual Nozzle Replacement & Coarse Alignment**
Applicable Systems: **Micron 9800 FlipChip**
Frequency of Service: **As Needed**

Overview of the Replacement Procedure

This service procedure describes the removal and replacement of the tri, quad, and beehive nozzles. It also includes procedures for coarse alignment of the nozzles prior to pump down.

This procedure refers to the two sets of nozzles as Nozzle 1 (on the left as you look from the front of the system) and Nozzle 2 (on the right).

The dual nozzle assembly moves both nozzles along the X and Y axis, but in the Z axis only one nozzle subassembly can move at a time. The order of the procedures is as follows:

- Part 1: Checking the Replacement Nozzles
- Part 2: Recording the Position of the Existing Nozzles
- Part 3: System Preparation
- Part 4: Cooling Off the Reservoir
- Part 5: Removing a Reservoir Subassembly
- Part 6: Replacing a Reservoir
- Part 7: Adjusting Limit Switches During Coarse Alignment
- Part 8: Coarse Alignment in Z: Nozzles do not Contact the Stage
- Part 9: Coarse Alignment in X and Y
- Part 10: Removing a GAE Nozzle Subassembly
- Part 11: Replacing a GAE Nozzle Subassembly with a Reservoir

Tools and Materials

This procedure requires the use of the following materials:

- Standard field service engineer’s tool kit
- Long-shaft slotted screwdriver
- Needle-nose pliers
- Clean-room gloves

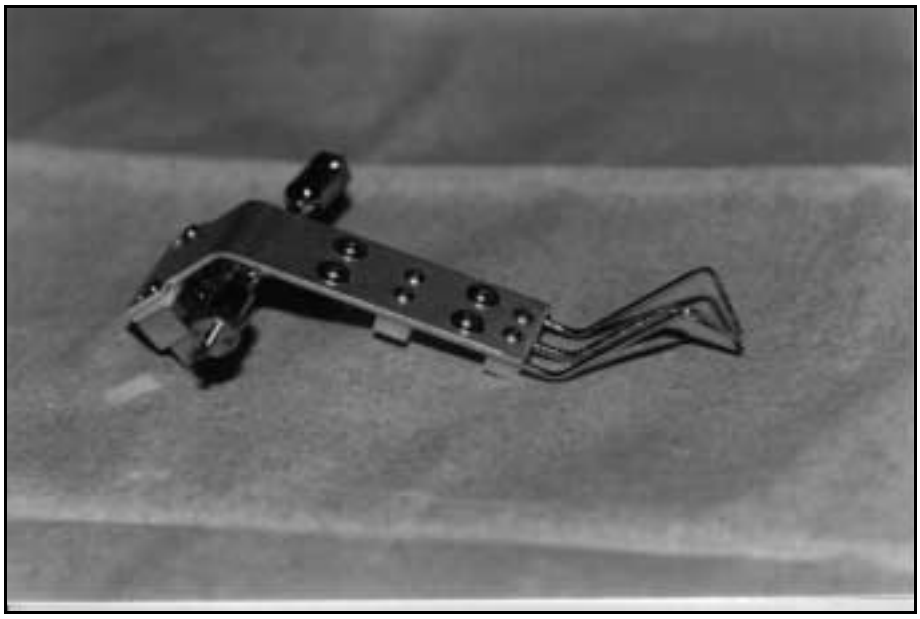


Figure 1. Tri Nozzles

To Name and Define the Nozzles

In the `/usr/micrion/fib/data/depo_labels` directory, are two template files defining in hexadecimal the extended position of each of the nozzle subassemblies. You can edit the two files to change the names of the nozzle subassemblies and the x, y, z, and z_id values. The template file defines the left subassembly as 1 and the right subassembly as 2. The following example shows the names and definitions as included in the template files. **The template files name a Tungsten reservoir as Nozzle 2 and a GAE (XeF2) as Nozzle 1**. The following is what you see in the depo_labels file:

```
::::::::::::::::::
Tungsten
x = 0200, y = 0000, z = 0400, z_id = 2
::::::::::::::::::
XeF2
x = 7000, y = 0000, z = 0500, z_id = 1
::::::::::::::::::
```

To Select a Nozzle

You can select a nozzle in either the *Microsurgery* screen menu or in *vacchat*.

To select a nozzle in Microsurgery,

In the screen main menu, select *Deposition*. On the deposition pulldown menu are the names of the nozzles and the `Retract` selection. In the template, the names are **Tungsten** and **XeF2**.

When you select one of the two names, that nozzle automatically is extended.

To select a nozzle in *vacchat*,

Type the command:

```
dpu
```

The following menu appears:

```
1. Extended
2. Tungsten
3. XeF2

A. Add label
C. Copy label
R. Rename label
D. Delete label
Q. Quit
Select Deposition Nozzle position label/option: [n]
```

When you enter 2 or 3, the x, y, and z extended positions are displayed in hexadecimal, microns, and mils. You are prompted as follows:

```
Active Deposition Nozzle... (1 = Z, 2 = Z2): [n]
```

In the examples above, *n* will be the number of the nozzle that was most recently selected.

X, Y, and Z Directions

From the front of workchamber, here are the directions of movement:

Table 1: Depo Nozzles: X, Y, and Z Directions

Axis	Direction	Limit
X	Right (East)	Positive
X	Left (West)	Negative (Home)
Y	Forward (toward rear)	Positive
Y	Back (toward front)	Negative (Home)
Z	Up	Positive
Z	Down	Negative (Home)

NOTICE

Per paragraph 11.1 of *Safety Guidelines for Semiconductor Manufacturing Equipment* (S2-93), this procedure is a Type 5 task. Specifically: "Equipment is energized. Measurements and adjustments require physical entry into the equipment."

Part 1. Checking the Replacement Nozzles

Inspect the nozzles for proper shape and bend radius; the Z-axis bend must be 90 deg or greater for each nozzle.

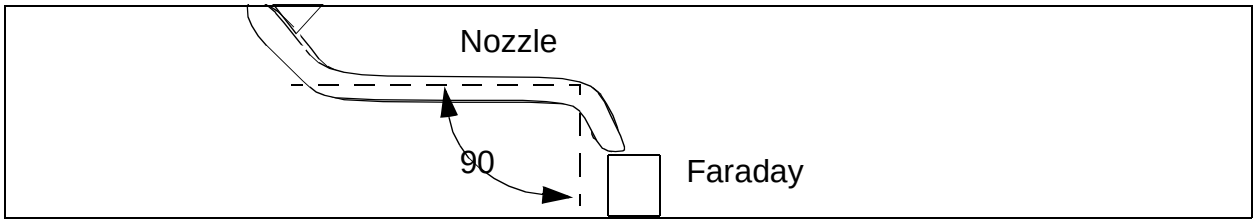


Figure 2. Side View: Correct Nozzle Bend: Greater than 90 deg.

Part 2. Recording the Position of the Existing Nozzles

Beginning with the workchamber under vacuum, proceed as follows:

2-1. From the Stage Control window in Microsurgery, select *Electron Faraday* and *GoToLabel.*

2-2. From the main *Microsurgery* screen, select *Depo Nozzle,* and from the pulldown menu select the name of the nozzle subassembly you plan to replace. Automatically the nozzle is extended.

2-3. As you view the position of the nozzle(s), record the image via the screen printer to compare with the image taken later, when the replacement is complete.

Part 3. System Preparation

Configuring the Chemical Sources in "Safe" Mode

Before performing the tasks described in this procedure, you must put the chemical sources in a "safe" mode; see Service Procedure 02-01.

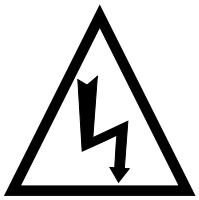
WARNING

Do not proceed until the chemical sources are secure. The chemical reservoirs in FIB systems contain hazardous materials. Labels affixed to the exterior of a chemical cabinet identify the chemical(s) contained inside. If a chemical source is not in its "safest" state, as described in **Service Procedure 02-01**, it is possible for a combination of component failures to release the chemical(s) through a cabinet's delivery line, a roughing line, a purging line, or from a chemical reservoir into the workchamber. Do not open the workchamber, or disassemble any part of the vacuum pumping system, or detach any gas line from any chemical cabinet until you are sure that every chemical source attached to the FIB system is in its "safest" state.

Power Down and Vent the System

Before performing the tasks described in this procedure, you must power down the high voltages and vent the system; see Service Procedure 01-02.

WARNING



Dangerously high voltages are present in the process module while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and automatic procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

Part 4. Cooling Off the Reservoir

4-1. On the left side of the outside of the workchamber, disconnect circular connector J1402.

4-2. Allow ten minutes for the reservoir to cool.

WEAR GLOVES, DO NOT HANDLE SOLVENTS

When working inside the chamber or when handling any components that will be exposed to vacuum, wear gloves rated for Class 100 environments or better. Due to disintegration of such gloves by solvents, do not handle solvents or parts that are wet with solvent.

Part 5. Removing a Reservoir Subassembly

Removing a reservoir means removing the reservoir and the heat sink at the same time. Once the reservoir-heat sink combination is removed, the reservoir can be separated and replaced.

5-1. Once the system is completely vented, remove the socket-head cap screws and open the workchamber.

5-2. From the main *Microsurgery* screen, select *Depo Nozzle*, and from the pulldown menu select *Retract.*

5-3. Using pair of needle-nose pliers, gently remove each gas tube where it meets its connector on the nozzle subassembly.

5-4. Locate the two screws on the heat sink braid clamp. Loosen the screws until the braid slips free.

5-5. Disconnect the power cable to the reservoir heater.

5-6. Loosen and remove the three nylon screws that hold the reservoir and its heat sink to the mounting base.

5-7. Lift the reservoir-heat sink combination out of the subassembly and turn it upsidedown.

5-8. With a flat-head screwdriver, remove the four nylon screws going up into the reservoir.

5-9. Being careful not to dislodge the four nylon washers between the reservoir and heat sink, turn the reservoir-heat sink combination rightsideup.

5-10. Remove the reservoir and dispose according to site regulations.

Part 6. Replacing a Reservoir

Perform Part 5 in reverse, using the same heat sink, as follows:

6-1. Check that the four nylon washers are in place before replacing the reservoir.

NOTICE

Nylon screws, if tightened with too much pressure, often break. Snug-tighten the nylon screws with care.

6-2. With the heat sink upsidedown, place the reservoir inside; replace and snug-tighten the four nylon flat-head screws.

6-3. Turn the reservoir-heat sink combination rightsideup and place it on the mounting base.

6-4. Replace and snug-tighten the three nylon screws that hold the reservoir-heat sink combination to the mounting base.

6-5. Connect the power cable to the reservoir heater.

6-6. Insert the heat sink braid into the clamp and tighten the two screws.

6-7. Replace the gas tubes onto their proper fittings:

Clear tube = GAE; White tube = O_2; and Black tube = TMCTS.

6-8. On the left side of the outside of the workchamber, connect circular connector J1402.

Figure 3. Heat sink braid being installed

Adjusting Limit Switches During Coarse Alignment

Find the switches shown in Fig. 4.

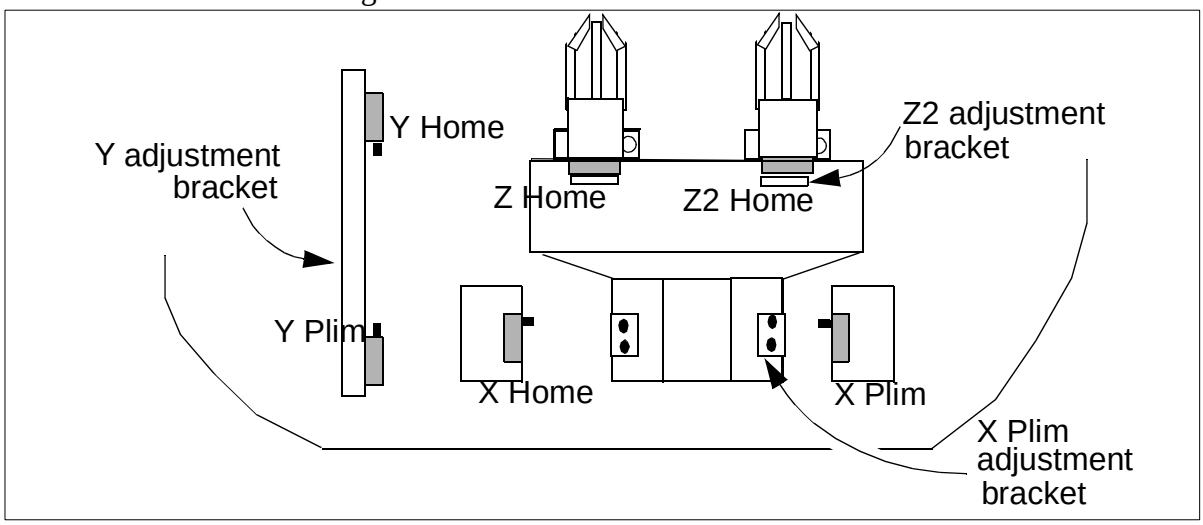


Figure 4. Dual mezzanine limit switches

In Parts 7 and 8, you make coarse alignments in Z, X, and Y. It may be necessary to adjust the limit switches for one or more of these axes.

Part 7. Coarse Alignment in Z: Nozzles do not Contact the Stage

With the chamber still vented, exercise the replaced reservoir nozzle subassembly as follows:

7-1. From the *Microsurgery* main menu, select *Depo Nozzle*.

7-2. From the pulldown menu, select *Retract*.

7-3. After the nozzle subassembly is retracted, from the same menu select *Extend*.

7-4. If the nozzles touch the stage, you will see the *vacchat* message:
`IN CONTACT with surface`

If the nozzles touch metal, the depo motor driver stops. If the nozzles touch non-metal e.g., the mirror shown in Fig. 5, the depo motor will not stop and no message will be reported. In such a case the nozzles will continue to move even though in contact, and they can be damaged.

In either case, the Z upper limit switch must be adjusted so the nozzles clear the stage rails and the mirror by 2 mm or less, *but cannot touch*.

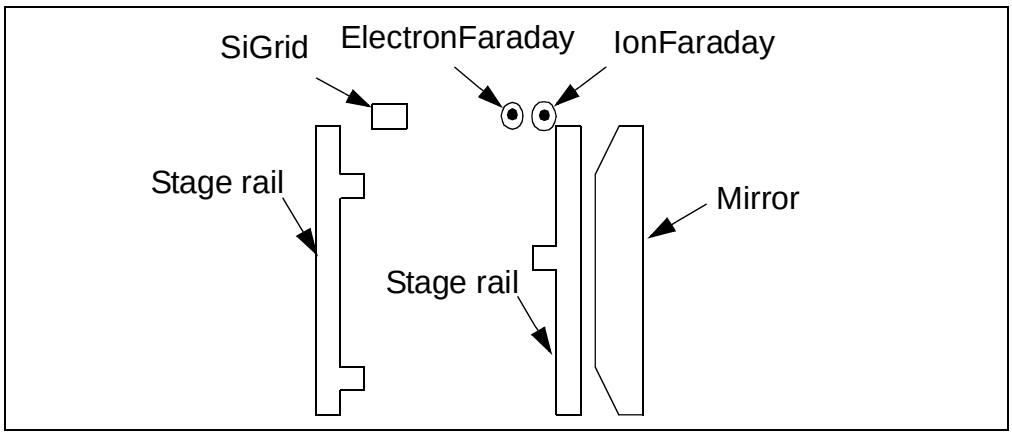


Figure 5. Stage rails and mirror

Note: If the nozzles are adjusted higher than 2 mm they will touch the MCP on the column when the chamber is under vacuum.

7-5. If the nozzle is in contact with the stage, raise the upper (Home) limit switch.

7-6. Repeat steps 7-3 through 7-5.

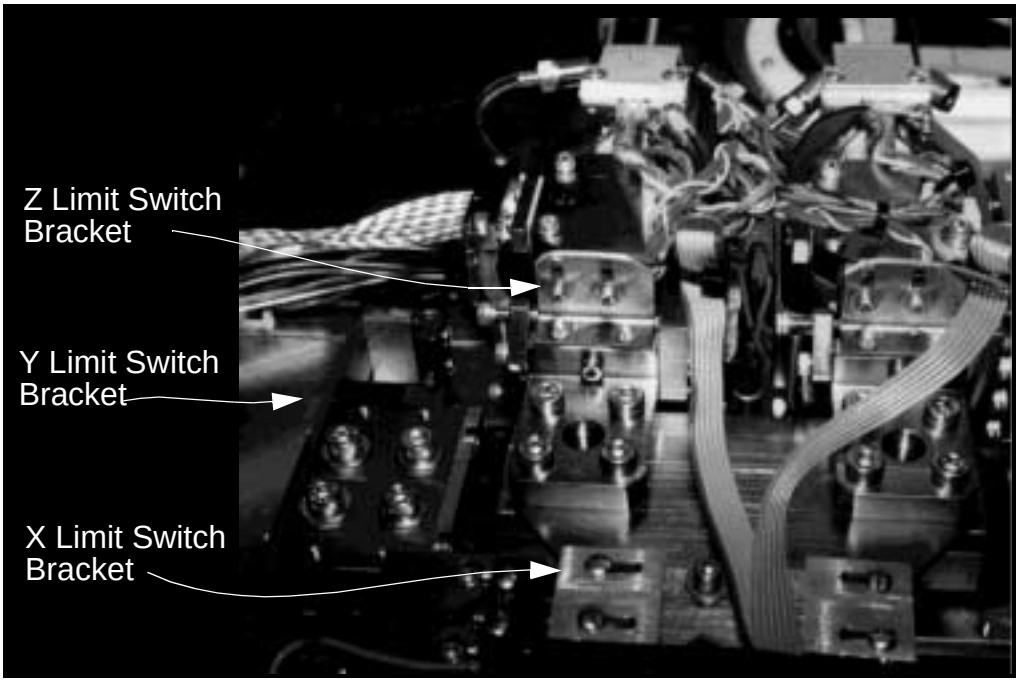


Figure 6. Home Limit Switches

7-7. To retract the nozzle, type the following *vacchat* command:

```
jr
```

7-8. Extend again and check that the nozzle subassembly follows the same path.

In Service Procedure 10-03, with the chamber under vacuum, finer alignment is made.

Part 8. Coarse Alignment in X and Y

With the chamber still vented, and the nozzles extended, use the following procedures to align the nozzles along the X- and Y-axes.

8-1. By eye, see that the nozzles are within 1 to 2 mm of either side of the faraday cup, as shown in Fig. 7.

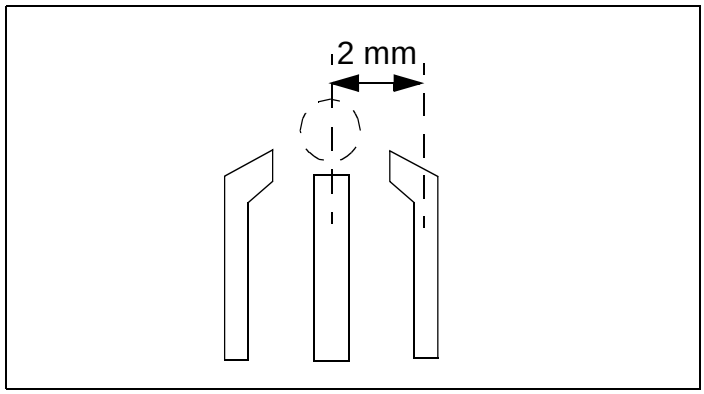


Figure 7. Top view: Tri nozzles 1-2 mm to either side of faraday cup

8-2. The Y plim switch should make contact before the nozzle goes past the faraday cup. As you can see in Fig. 8, if the nozzle is bent backward (i.e., at less than 90 deg.) the nozzle will contact the MCP.

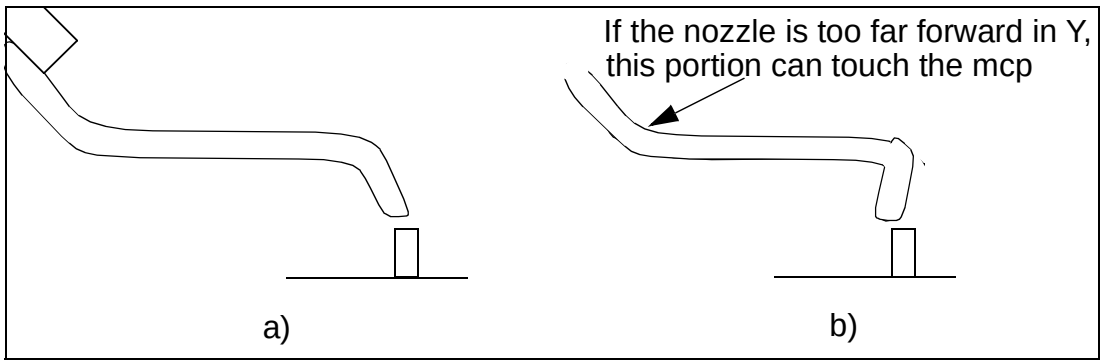


Figure 8. Side view: A correct bend (a) and an incorrect bend (b)

In Service Procedure 10-03, with the chamber under vacuum, finer alignment is made.

Part 9. Removing a GAE Nozzle Subassembly

A “beehive” GAE nozzle is a single nozzle delivering gas for etching. One such nozzle is shown in Fig. 9. A GAE nozzle subassembly is removed only when it is broken or is to be replaced with a reservoir nozzle subassembly. Removing a GAE nozzle subassembly means removing the nozzle and the insulator at the same time.

Figure 9. GAE “Beehive” Nozzle

9-1. From the main *Microsurgery* screen, select *Depo Nozzle,* and from the pull down menu select *Retract.*

9-2. Using pair of needle-nose pliers, gently remove the gas tube where it meets its connector on the nozzle subassembly.

9-3. Disconnect the grounding wire.

9-4. Loosen and remove the three nylon screws that hold the nozzle subassembly and its insulator to the mounting base of the subassembly.

9-5. Lift the nozzle subassembly and the insulator out of the subassembly. The insulator can be separated by hand. This insulator can be re-used if the GAE nozzle subassembly is being replaced. If a reservoir subassembly is being installed, the old insulator is not needed.

9-6. If no longer needed, return the nozzle subassembly to Micrion Customer Service.

Part 10. Replacing a GAE Nozzle Subassembly with a Reservoir

To replace a GAE nozzle subassembly with a Tungsten reservoir nozzle subassembly, the following parts are required:

- Copper cooling braid with clamp and two screws
- Heater board and harness connector
- Reservoir-heat sink combination already fastened by four nylon screws and washers

NOTICE

Nylon screws, if tightened with too much pressure, often break. Snug-tighten the nylon screws with care.

10-1. Place the reservoir-heat sink combination on the mounting base.

10-2. Insert and snug-tighten the three nylon screw that hold the reservoir-heat sink combination to the mounting base.

10-3. Connect the power cable to the reservoir heater connector.

10-4. Insert the copper braid into the clamp and tighten the two screws.

10-5. Replace the gas tube into its proper receptacle.

10-6. Connect the grounding wire.

10-7. On the left side of the outside of the workchamber, connect circular connector J1402.

10-8. Follow the procedures in Parts 7 and 8 to coarsely align the nozzles in X, Y, and Z.

Micrion

Service Procedure No.: **10-03**
Service Procedure Title: **Dual Nozzle Fine Alignment**
Applicable Systems: **Micrion 9800 FlipChip**
Frequency of Service: **After Nozzle Replacement, Lateral Axis Alignment or Source Change**

Overview of the Alignment Procedures

Alignment is the process of bringing a nozzle subassembly into the beam path, close enough to the mask or wafer to enable milling or deposition. The objective of this procedure is to minimize travel in all directions while achieving the necessary positions. Care must be taken in wire routing to allow free travel on all axes.

In the alignment in X, Y, and Z axes, it may be necessary to pump down and vent the chamber a number of times. This procedure is organized to minimize the number of times you have to go through the pump and vent cycle.

- Part 1: Power Up the System and Place the Chamber Under Vacuum
- Part 2: Coarse Alignment in Z: Nozzles Clear the Column
- Part 3: Fine Alignment in X and Y
- Part 4: Fine Alignment in Z
- Part 5: Verifying Deposition

Tools and Materials

This procedure requires the use of the following materials:

- Standard field service engineer’s tool kit
- Long-shaft slotted screwdriver
- Needle-nose pliers
- 3/32" Allen wrench

Software Definitions

- The locations of Ion Faraday and Electron Faraday defined

Trademarks

Loctite

To Name and Define the Nozzles

In the `/usr/micrion/fib/data/depo_labels` directory, are two files defining in hexadecimal the extended position of each of the nozzle subassemblies. The names of the nozzles can be changed and the x, y, z, and z_id values can be changed. The template file defines the left subassembly as Z1 and the right subassembly as Z2:

```
::::::::::::::::::
Tungsten
x = 0200, y = 0000, z = 0400, z_id = 2
::::::::::::::::::
XeF2
x = 7000, y = 0000, z = 0500, z_id = 1
::::::::::::::::::
```

To Select a Nozzle

You can select a nozzle in either the *Microsurgery* screen menu or in *vacchat*.

To select a nozzle in *Microsurgery*,

In the screen main menu, select *Depo Nozzle*. On the deposition pull down menu are the names of the nozzles as defined in the `depo_label` files, along with the `Retract` selection. When you select one of the two names, that nozzle automatically is extended.

To select a nozzle in *vacchat*,

Type the command:

```
dpu
```

The following menu appears:

```
1. Extended
2. Tungsten
3. XeF2

A. Add label
C. Copy label
R. Rename label
D. Delete label
Q. Quit
Select Deposition Nozzle position label/option: [n]
```

When you enter 2 or 3, the x, y, and z extended positions are displayed in hexadecimal, microns, and mils. You are prompted as follows:

```
Active Deposition Nozzle ... (1 = Z, 2 = Z2): [n]
```

In all cases, *n* will be the number of the nozzle that was most recently selected.

X, Y, and Z Directions

From the front of workchamber, here are the directions of movement:

Table 1: Depo Nozzles: X, Y, and Z Directions

Axis	Direction	Limit
X	Right (East)	Positive
X	Left (West)	Negative (Home)
Y	Forward (away from front)	Positive
Y	Back	Negative (Home)
Z	Up	Positive
Z	Down	Negative (Home)

At its retracted or Home position, nozzles are at the middle of X lead screw, Y back, and Z up.

NOTICE

Per paragraph 11.1 of *Safety Guidelines for Semiconductor Manufacturing Equipment* (S2-93), this procedure is a Type 3 task. Specifically: "Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are less than 30 volts RMS, 42.2 volts peak, 240 volt-amps, and 20 Joules."

Part 1. Power Up the System and Place the Chamber Under Vacuum

Before performing the tasks described in this procedure, you must power up the ion beam as described in Service Procedure 01-02. Then place the chamber under vacuum as described in Service Procedure 04-03.

Part 2. Coarse Alignment in Z: Nozzles Clear the Column

In Service Procedure 10-2, you checked that the nozzles do not touch the stage rails or the mirror. Now, in the second of the Z coarse adjustments, you check that the nozzles do not touch the column (actually the MCP on the column). To align along the Z axis, use the upper limit switches. The lower limit switches are not accessible.

2-1. Set acceleration to 30 kV.

2-2. Set the field of view to 1350 µm, the resolution to 1024, and the aperture to 100 µm.

2-3. Make a print of the screen when the nozzle is fully extended over step 2 of the diagnostic block, and compare it with the print taken of the old nozzle before you replaced it (see Service Procedure 10-02, step 2-3).

2-1. From the Stage Control window, select *Step2* and *Go To Label*.

2-2. In *vacchat*, type a `jx` command to extend the nozzle.

2-3. If *vacchat* sends you the `IN CONTACT with surface` message, raise the upper limit switch, as shown in Fig . If *vacchat* sends you the `IN CONTACT with surface` message, raise the upper limit switch, as shown in Figs 1 and 2.

2-4. Repeat steps 2-2 and 2-3.

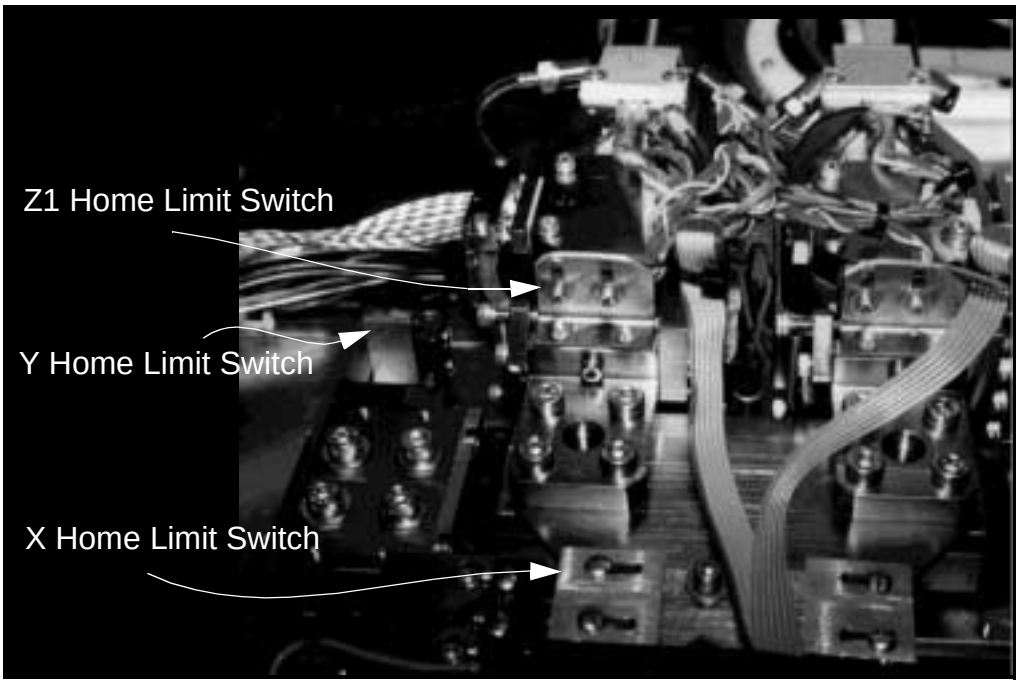


Figure 1. Home X, Y, and Z limit switches

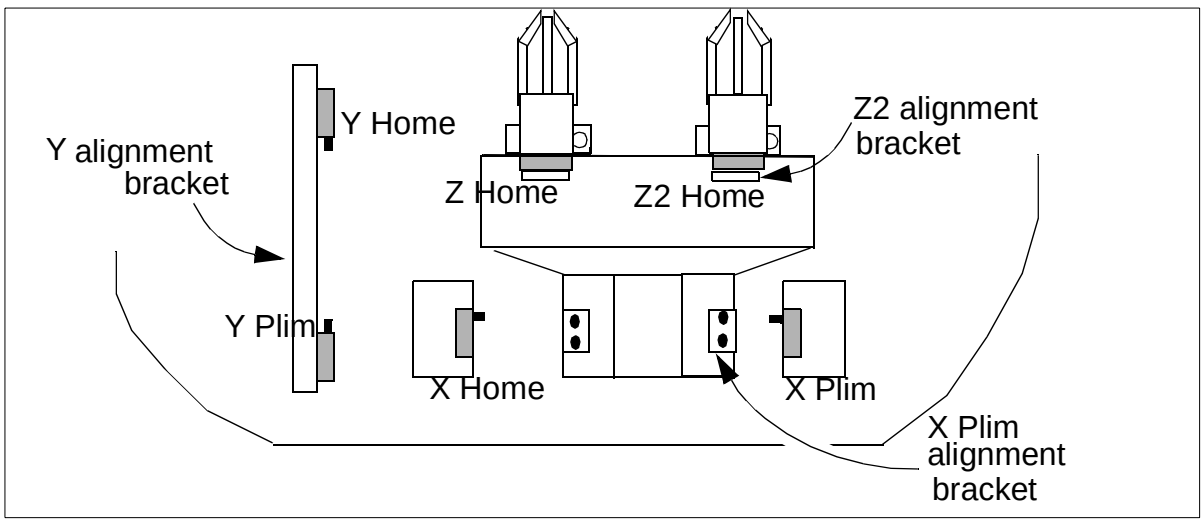


Figure 2. Location of Depo Limit Switches

Part 3. Fine Alignment in X and Y

With the nozzle(s) extended over Step 2 of the diagnostic block, the goal is to align the Tungsten nozzle within 350-500 µm of the beam center, and the XeFl nozzle within 500-700 µm of the beam center.

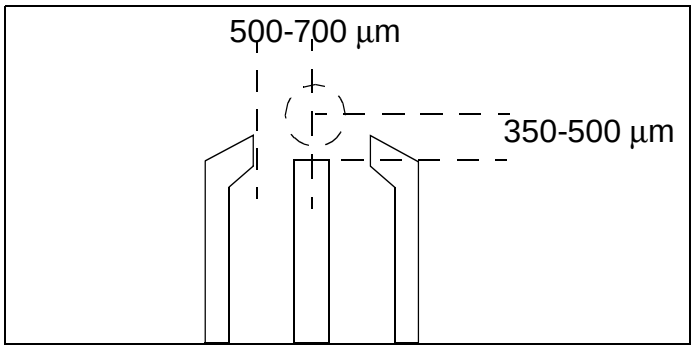


Figure 3. Tri Nozzle Configuration at FOV 1350

The X axis travel commands, JE and JW (jog east and jog west) will move the nozzle(s) 158 µm on each repetition of a command.

The Y axis travel commands, JF and JB (jog forward and jog back) will also move the nozzle(s) 158 µm on each repetition of a command.

After each repetition, use the measurement tool to determine how far from center you are.

3-1. If in the screen image the nozzles are misaligned, move the limit switch alignment brackets as listed in Table 2 and shown in :

Table 2: Adjusting the alignment brackets

Nozzle Problem	Limit Switch Bracket	Direction of adjustment
Too far right (east)	X Plim	To the right
Too far left (west)	X Home	To the left
Too far to the rear	Y Home	Toward back of chamber
Too far to the front	Y Plim	Toward front of chamber

3-2. Save your final setting as follows:

a. Type the *vacchat* commmand that reports the old setting:

dpu

b. Select the nozzle you are working with (1 or 2).

c. To save settings, press the Enter key.

This will save the new settings for X and Y.

Part 4. Fine Alignment in Z

With the selected nozzle(s) extended over Step 2 of the diagnostic block, the goal is to align the nozzle(s) within 350-500 µm of the beam center.

The Z axis travel commands, JU and JD (jog up and jog down) will move the nozzle(s) 32 µm on each repetition of the command. After each repetition, use the measurement tool to determine how far from center you are. To reach the ideal distance, which is shown in Fig. 3, you can change the Z value.

Begin by making contact with the nozzle(s) on step 2 of the diagnostic block.

Basic Units

- 350-750 microns above the sample is the ideal nozzle position
- 25.4 microns per mil

Table 3: Distance in microns moved per vacchat nozzle command

Vacchat commands	2000	8000	9000	9800
Z: `ju, jd`	20 µm	32 µm	16 µm	32 µm
X: `je, jw`	158 µm	n/a	100 µm	158 µm
Y: `jf, jb`	1.10 deg	n/a	n/a	158 µm

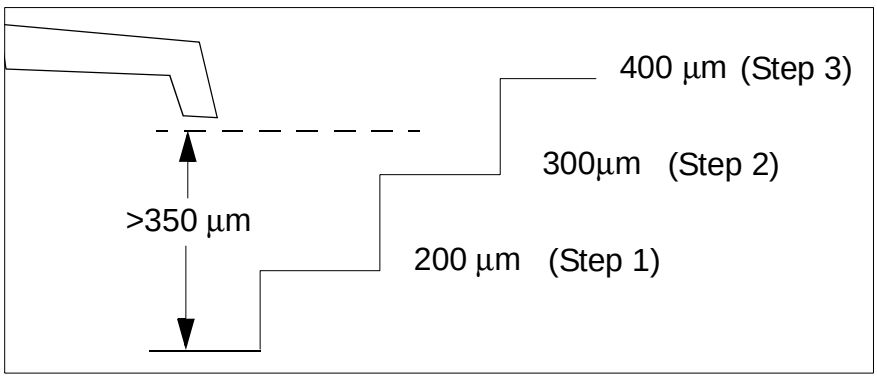


Figure 4. Diagnostic Block: Nozzle Distance in the Z Direction

4-1. Extend the nozzles with the `jx` command.

4-2. Type an `sddc` command to see if you get the message `IN CONTACT with surface`.

4-3. If the nozzles are not in contact, type the `jd` command until you come into contact.

4-4. When the nozzles are finally in contact with step 2, type two `ju` commands in *vacchat* to move the nozzle jogs up to a position approximately 64 µm above step 2 and a total of 364 µm above the mask or wafer.

If you want the nozzles farther from the mask of wafer, type the `ju` command, which raises nozzles 32 µm per command. When the position is acceptable, save your Z setting.

4-5. Type the *vacchat* commmand that reports the old setting:

```
dpu
```

4-6. Select the nozzle you are working with (1 or 2).

4-7. To save settings, press the Enter key.

4-8. Type the `jr` command to retract the nozzle. (The nozzle will be prevented from retracting if it is still in contact with step 2.)

Part 5. Verifying Deposition

- Conduct a series of depositions at 1-2 nC/µm^2 .
- Ensure that the gas is not in depletion mode; the dac, dwell, and refresh are within spec.
- Inspect the depositions for coverage and for 1000 µm-long deposition.

Micron

Service Procedure No.: **10-04**
Service Procedure Title: **Funnel Replacement**
Applicable Systems: **8000**
Frequency of Service: **As Needed**

Overview of the Replacement Procedure

Replacement of the funnel includes five main operations:

- Imaging the existing funnel
- Powering down and venting; putting chemicals in the safe mode
- Removing the existing funnel
- Putting the new funnel in its place
- Setting the temperatures on the heater board and the cooler board

In this procedure are a photo of the funnel and its gas tubes; and a photo of the two socket-head screws that attach the funnel bracket to the mezzanine.

Tools and Materials

This procedure requires the use of the following materials:

- Standard field service engineer's tool kit
- 3/32" Allen wrench
- Needle-nose pliers
- Clean-room gloves

NOTICE

Per paragraph 11.1 of *Safety Guidelines for Semiconductor Manufacturing Equipment* (S2-93), this procedure is a Type 5 task. Specifically: "Equipment is energized. Measurements and adjustments require physical entry into the equipment."

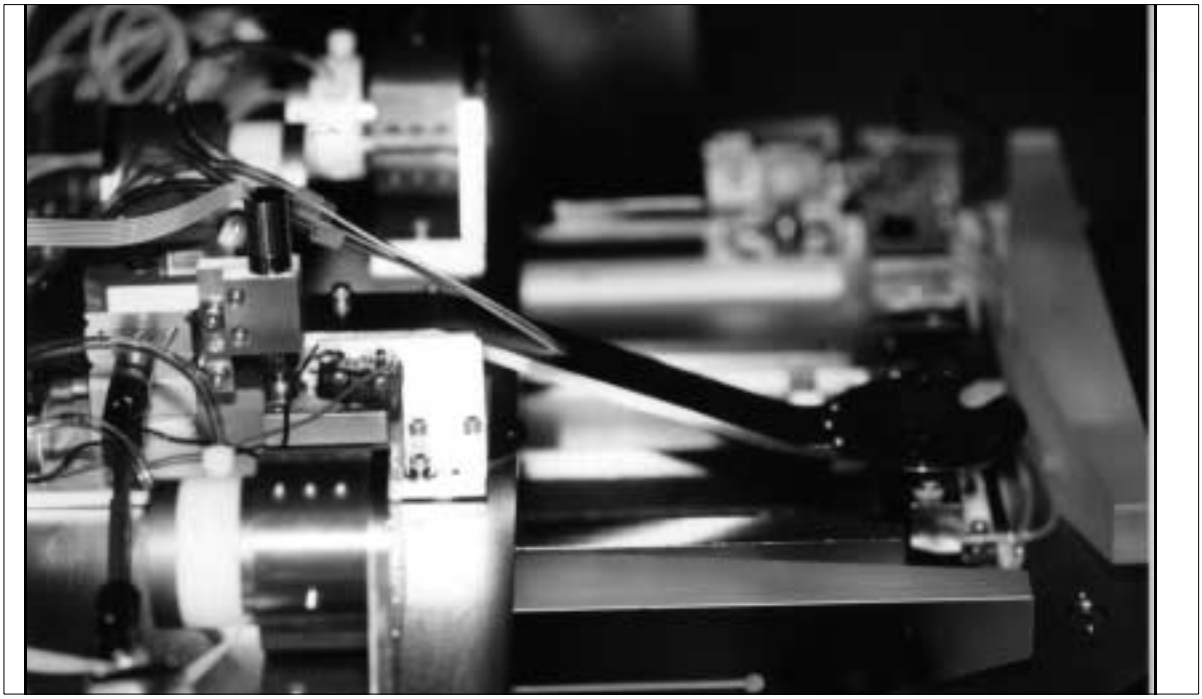


Figure 1. Deposition Funnel

Configure the Chemical Sources in "Safe" Mode

Before performing the tasks described in this procedure, you must put the chemical sources in a "safe" mode; see Service Procedure 02-01.

WARNING

Do not proceed until the chemical sources are secure. The chemical reservoirs in FIB systems contain hazardous materials. Labels affixed to the exterior of a chemical cabinet identify the chemical(s) contained inside. If a chemical source is not in its "safest" state, as described in **Service Procedure 02-01**, it is possible for a combination of component failures to release the chemical(s) through a cabinet's delivery line, a roughing line, a purging line, or from a chemical reservoir into the workchamber. Do not open the workchamber, or disassemble any part of the vacuum pumping system, or detach any gas line from any chemical cabinet until you are sure that every chemical source attached to the FIB system is in its "safest" state.

Part 1. Recording the Position of the Existing Funnel

Beginning with the workchamber under vacuum, proceed as follows:

1-1. From the Stage Control window in Microsurgery, select *Electron Faraday* and *GoToLabel.*

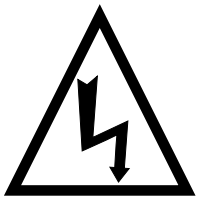
1-2. Set the field of view to 1350 µm, the resolution to 1024, and the aperture to 100 µm.

1-3. As you view the position of the funnel, record the image via the screen printer to compare with the image taken later, when the replacement is complete.

Power Down and Vent the System

Before performing the tasks described in this procedure, you must power down the high voltages and vent the system; see Service Procedure 01-02.

WARNING



Dangerously high voltages are present in the process module while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and automatic procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

1-4. On the left side of the outside of the workchamber, disconnect circular connector J1402.

1-5. Once the system is completely vented, remove the socket-head cap screws and open the workchamber.

WEAR GLOVES, DO NOT HANDLE SOLVENTS

When working inside the chamber or when handling any components that will be exposed to vacuum, wear gloves rated for Class 100 environments or better. Due to disintegration of such gloves by solvents, do not handle solvents or parts that are wet with solvent.

Part 2. Removing a Funnel

2-1. Using pair of needle-nose pliers, gently remove each gas tube where it meets its connector on the funnel bracket.

2-2. Locate the two screws at the top of the funnel bracket. Loosen the two screws until the bracket slips free.

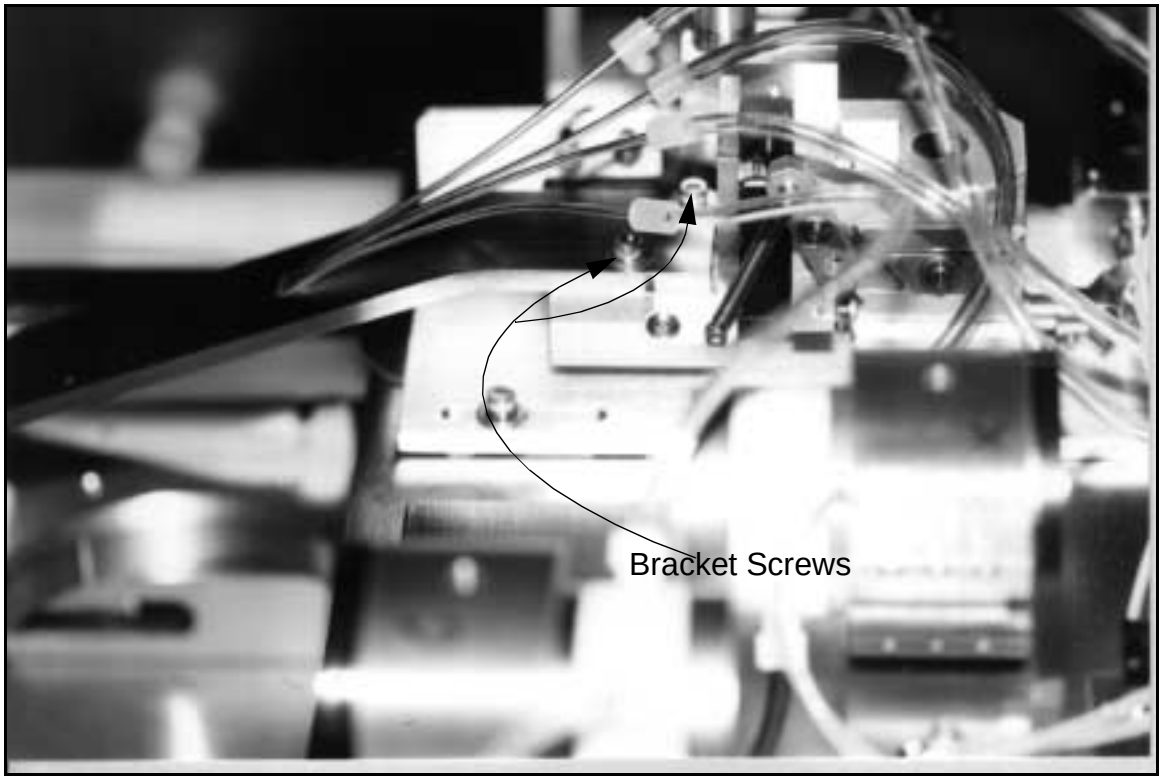


Figure 2. Three Tubes and Two Bracket Screws on Funnel

Part 3. Replacing a Funnel

Perform Part 2 in reverse.

3-1. Attach the funnel bracket with the two screws.

3-2. Replace the gas tubes onto their proper barb fittings: Clear tube = GAE; White tube = O_2; and Black tube = TMCTS.

3-3. On the left side of the outside of the workchamber, connect circular connector J1402.

Part 4. Setting the Temperatures on the Heater Board

See Service Procedure 10-07

Micrion

Service Procedure No.: **10-05**
Service Procedure Title: **Funnel Alignment**
Applicable Systems: **8000**
Frequency of Service: **After Lateral Axis Alignment or Source Change**

Overview of the Alignment Procedures

Alignment of the funnel includes four main steps:

- Coarse adjustment
- Power up and pump down
- Fine adjustment
- Fine alignment

In this procedure is a photo of the X and Y alignment knobs.

Tools and Materials

This procedure requires the use of the following materials:

- *Vacchat* program

NOTICE

Per paragraph 11.1 of *Safety Guidelines for Semiconductor Manufacturing Equipment* (S2-93), this procedure is a Type 3 task. Specifically: "Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are less than 30 volts RMS, 42.2 volts peak, 240 volt-amps, and 20 Joules."

Part 1. System Preparation

Configure the Chemical Sources in "Safe" Mode

Before performing the tasks described in this procedure, you must put the chemical sources in a "safe" mode; see Service Procedure 02-01.

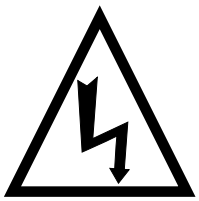
WARNING

Do not proceed until the chemical sources are secure. The chemical reservoirs in FIB systems contain hazardous materials. Labels affixed to the exterior of a chemical cabinet identify the chemical(s) contained inside. If a chemical source is not in its "safest" state, as described in **Service Procedure 02-01**, it is possible for a combination of component failures to release the chemical(s) through a cabinet's delivery line, a roughing line, a purging line, or from a chemical reservoir into the workchamber. Do not open the workchamber, or disassemble any part of the vacuum pumping system, or detach any gas line from any chemical cabinet until you are sure that every chemical source attached to the FIB system is in its "safest" state.

Power Down and Vent the System

Before performing the tasks described in this procedure, you must power down the high voltages and vent the system; see Service Procedure 01-02.

WARNING



Dangerously high voltages are present in the process module while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and automatic procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

Open the Workchamber

Remove the front panels to gain access to the workchamber cover. When the system is completely vented, remove the 1/2" socket-head cap screws and open the workchamber.

Part 2. Coarse Adjustment

2-1. By eye, see that the funnel is over the electron faraday.

2-2. If necessary, adjust the X and Y knobs (see Fig. 1) to align the funnel. When you adjust the funnel in X or Y, Z will also be affected.

Part 3. Power Up and Pump Down

3-1. Close the workchamber door and secure the socket-head cap screws.

3-2. Use the power-up procedure, Service Procedure 01-01.

3-3. Follow Service Procedure 04-03 to pump down the system to vacuum.

3-4. Initiate the *Mask Repair* program, and power up the column.

Part 4. Fine Adjustment

4-1. Set acceleration to 30 kV.

4-2. Set the field of view to 1350 μm, the resolution to 1024, and the aperture to 100 μm.

4-3. If the stage is not already at the Electron Faraday, from the Stage Control window in Microsurgery, select *Electron Faraday* and *GoToLabel.*

4-4. Make a print of the screen and compare it with the print taken of the old nozzle before you replaced it (see Service Procedure 10-04, step 1-2).

Part 5. Fine Alignment in X, Y, and Z

The X and Y adjustment knobs (see Fig. 1) are on the outside of the workchamber, to the right of the loadlock as you face the machine.

Figure 1. Adjustment Knobs: Y (left) and X (right)

5-1. To view the funnel just inside the image screen, reduce the voltage to 20 kV.

5-2. To center the funnel within the image screen, turn the X and Y knobs as needed. Any alignment in X will slightly change the alignment in Y and vice-versa.

5-3. To adjust in the Z axis, type the *vacchat* command:

```
dpu
```

When the current Z position is shown (in hexadecimal, in microns, and in mils), type in a new hexadecimal number as needed. As a rule, there are 12-16 microns per least significant hexadecimal position

5-4. Once the Z position is set, readjust the X and Y settings as needed; then type the `dpu` command in *vacchat* to verify the Z setting.

Service Procedure No.: **10-06**
Service Procedure Title: **Verifying Depo Limit Switch Settings**
Applicable Systems: **Micrion 9800 FlipChip**
Frequency of Service: **As Needed**

Overview of the Limit Switches

After installation of a reservoir, test the limit switches for proper signals. See Fig. 1.

The “home” switch is the switch contacted by the nozzle subassembly in the retracted position, which is also known as the Nlimit or negative limit switch.

The Plim, or positive limit switch is the switch contacted by the nozzle subassembly in the extended position.

In the following procedure, if a switch is not contacted, you will see an error message. If the switch is contacted, there is no message.

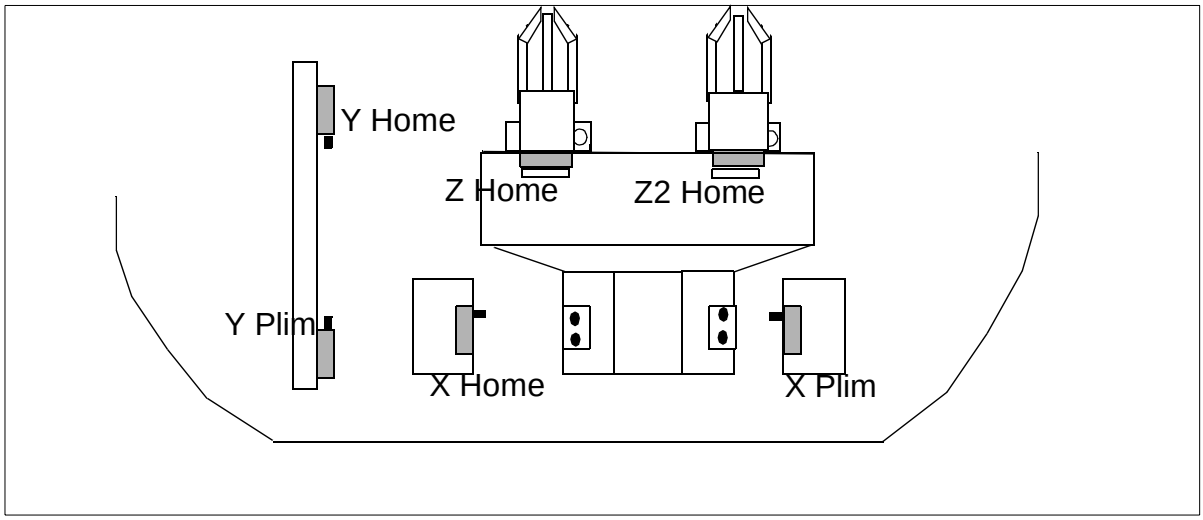


Figure 1. Location of Depo Limit Switches

Part 1. Verifying Limit Switch Values

Checking the Z Limit Switches

In *vacchat*, enter the following command to bring the nozzle subassembly to the home position, which in the X direction is contacting the leftmost limit switch in Figure l.

```
hz
```

To find the lower limit switch, type:

```
zpl
```

Checking the X Limit Switches

In *vacchat*, enter the following command to bring the nozzle subassembly to the home position, which in the X direction is contacting the upper limit switch:

```
hx
```

To find the positive limit switch, type:

```
xpl
```

Checking the Y Limit Switches

In *vacchat*, enter the following command to bring the nozzle subassembly to the home position, which in the Y direction is contacting the forward Y limit switch:

```
hy
```

To find the Y positive limit switch, type:

```
ypl
```

To Verify the Nozzle Position

To verify that the retract and extend positions have been detected by the limit switches, type the following three commands to get confirmation or denial by the system that the limit switches have been contacted:

```
sdzp
sdxp
sdyp
```

Micrion

Service Procedure No.: **10-07**
Service Procedure Title: **Making Heater and Cooler Board Settings**
Applicable Systems: **Micrion 9800 FlipChip, 8000**
Frequency of Service: **As Needed**

Part 1. Setting the Temperatures on the Heater Board

In this part, you make software settings on board 1583 and test the new subassembly. The following procedure assumes that the reservoir under discussion is VR2 (the one on the right). If the nozzle subassembly is actually the one on the left, then substitute VR for VR2 in all commands.

1-1. With the *vacchat* command, retract the nozzle subassembly: `jr`

1-2. Set potentiometers R8, R76, and R100 to their lowest settings (see Fig. 1).

Table 1: Temperature potentiometers and how to adjust them

Potentio-meter	Senses	Vacchat command	To Raise Temp	To lower Temp	Test point (50mV/°C
R76	valve	sh1mt	turn ccw	turn cw	TP1
R100	nozzle	sh1nt			TP2
R8	reservoir	sh1rt	turn cw	turn ccw	TP3
	setpoint	sh1sp			

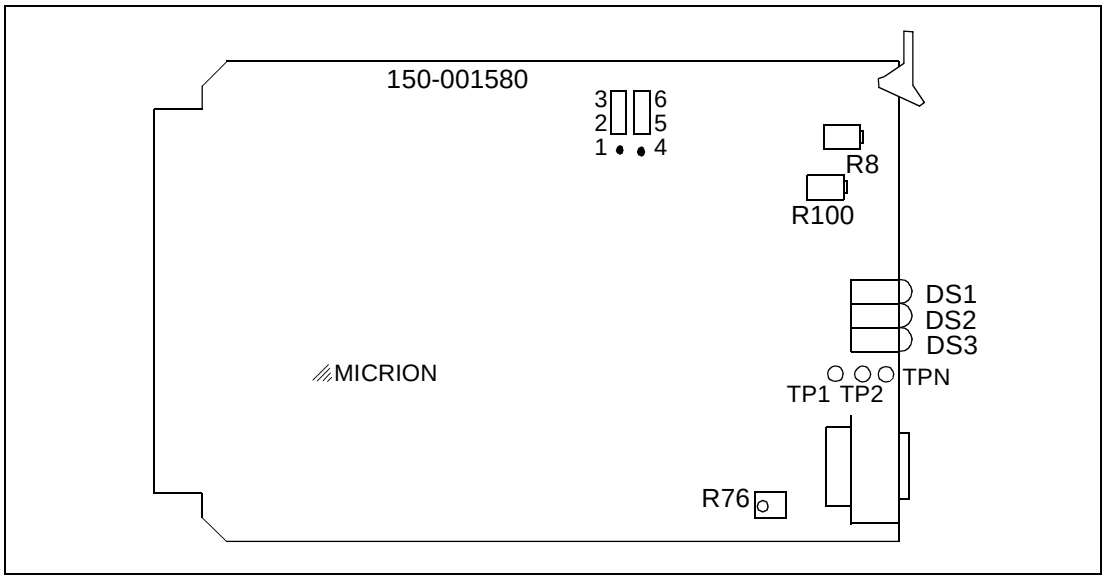


Figure 1. First Heater Board 2, 1583; Rev C

1-3. With the heater harness plugged into the reservoir, type the following *vacchat* commands and **record the results**:

```
sh1mt
```

This gives the valve temperature, which can also be seen at TP1 (50 mV/°C). DS1 on the heater board should NOT be lighted.

```
sh1rt
```

This gives the reservoir temperature, which can also be seen at TP2 (50 mV/°C). DS2 on the heater board should NOT be lighted.

```
sh1nt
```

This gives the nozzle temperature, which can also be seen at TPN (50 mV/°C). DS3 on the heater board should NOT be lighted.

1-4. Open the reservoir valve for five minutes:

```
opvr2
```

1-5. To verify that power is going to the heater valve, and that the valve is letting air into the reservoir, **record the increased valve temperature**:

```
sh1mt
```

1-6. Pump down the chamber as described in Service Procedure 04-02.

Part 2. Checking Temperatures under Vacuum

With the chamber under vacuum. proceed as follows:

2-1. **Record the valve temperature** with the following command:

```
sh1mt
```

2-2. To verify that the reservoir valve is opening under vacuum, when the HCIG = approximately 3.5 x 10^{-6} torr open VR (or VR2) and observe a pressure pulse due to residual air in the reservoir:

```
opvr2
```

2-3. Pump for five minutes with VR2 open. **Record the increase** in the valve temperature, which should be approximately 2° C.

```
sh1mt
```

2-4. Close VR2.

2-5. By trimming R100 and R76, bring the nozzle heater and the valve heater to approximately 55° C. Wait 1/2 hour to an hour or until the valve and nozzle temperatures stabilize, and **record both temperatures**.

```
sh1mt
sh1nt
```

2-6. Set the reservoir setpoint to 62° C by tweaking potentiometer R8 clockwise and typing the *vacchat* command:

```
sh1sp
```

2-7. In one hour, **record the reservoir, valve, and nozzle temperatures**, which should each be 62° C or above. (Valve temperature can be as high as 70° C, and nozzle temperatures can be as high as 75° C.)

```
sh1rt
sh1mt
sh1nt
```

2-8. Check for contact with the substrate.

2-9. Open VR2 for one hour and observe the cathode ion gauge (hot or cold) as a function of time. **Record the three sensor temperatures** as in step 2-7. After one hour, close VR2. Record the return to base pressure as a function of time.

Part 3. Setting the Temperature on the Cooler Board: TMCTS

In this part, you make software settings on board 1582 and test the new subassembly. This sets the temperature for the cooler that is next to the reservoir in the TMCTS gas cabinet.

3-1. On board 1582, set R8 to its lowest setting (fully counterclockwise). See Fig. 2.

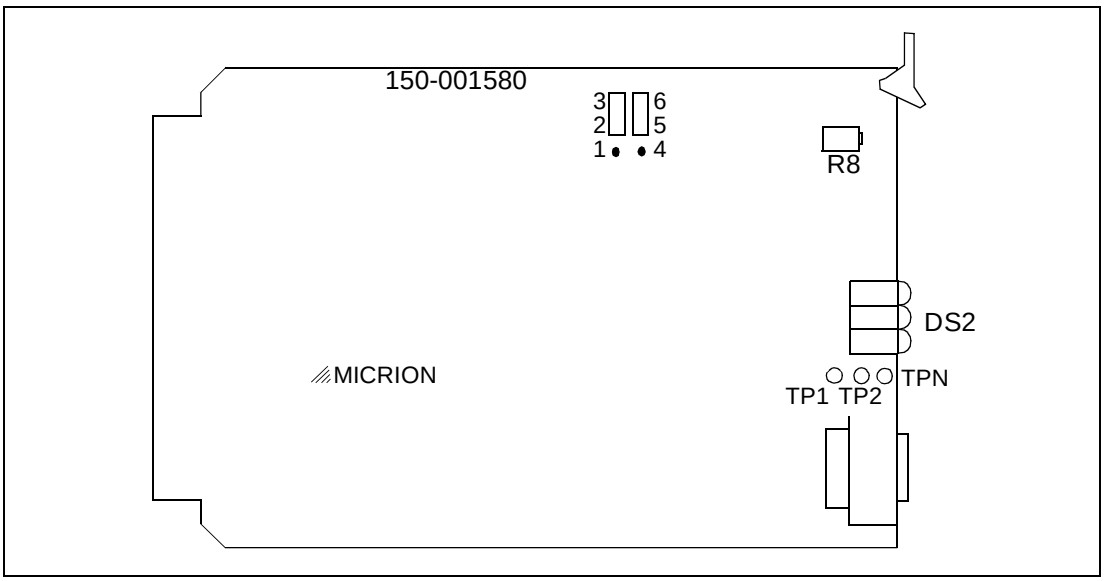


Figure 2. Cooler Board, 1582; Rev C

3-2. With the cooler harness plugged into the reservoir, type the following *vacchat* command and **record the results**:

```
sc2at
```

Sc2at gives the ambient temperature.

```
sc2ct
```

Sc2ct gives the reservoir control temperature, which can be seen at TP2 (50 mV/°C). (See Fig. 4.) The control temperature is the difference between the ambient and the set point. DS2 on the heater board should NOT be lighted.

```
sc2sp
```

Sc2sp gives the temperature set point.

Part 4. Checking Reservoir Temperature under Vacuum

Pump down the chamber as described in Service Procedure 04-02, and proceed as follows:

4-1. Set the reservoir setpoint to 62° C by tweaking potentiometer R8 clockwise and checking the temperature by typing:

```
sc2sp
```

4-2. In one hour, **record the reservoir temperatures**:

```
sc2ct
```

The temperatures should each be 62° C or above.

Section 11: Gas Cylinder Replacement

- 11-01 Chlorine Cylinder Replacement
- 11-02 Xenon Difuoride Cylinder Replacement
- 11-03 Bromine Cylinder Replacement
- 11-04 Carbon Cylinder Replacement
- 11-05 Oxygen Cylinder Replacment
- 11-06 Siloxane (TMCTS) Cylinder Replacement
- 11-07 Siloxane (TEOS) Cylinder Replacement

Micrion

Service Procedure No.: **11-01**
Service Procedure Title: **Chlorine Cylinder Replacement**
Applicable Systems: **All Systems w/ Cl_2**
Frequency of Service: **As Needed**

Introduction

Do not undertake this procedure without prior training and authorization by Micrion Corporation. Do not use this document as a substitute for training. Normally, only Micrion service personnel perform this procedure. This document has four parts: (1) preparations, (2) an outline of the procedure, (3) the procedure, and (4) the Material Safety Data sheet for chlorine (Cl_2) in Section 2.

NOTICE

Per paragraph 11.1 of Safety Guidelines for Semiconductor Manufacturing Equipment (S2-93), this procedure is a Type 3 task. Specifically: "Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are less than 30 volts RMS, 42.2 volts peak, 240 volt-amps, and 20 Joules."

Materials Required

- New (recharged) Cl_2 cylinder (procured from chemical supplier)
- New Teflon gasket for the CGA 660 coupling (normally comes with Cl_2 cylinder)
- SNOOP[1] liquid leak detector
- Protective CGA 660 cap for the "old" Cl_2 cylinder
- Chemical-resistant gloves
- Safety glasses
- Lint-free wipes and lint-free swabs
- Disposal bag for contaminated waste (used wipes, gaskets, etc.)
- 1-1/4" open end wrench for loosening the CGA 660 coupling
- 3/8" open end wrench for loosening the cylinder valve on the "new" cylinder (this wrench must be 10" to 12" long; as much as 100 ft.-lbs. of torque may be required)
- Torque wrench (Micrion part 780-114) with crowfoot wrench attachment (Micrion part 780-113) for tightening the CGA 660 coupling
- Hex key set (ratchet or screwdriver type recommended) for removing and reinstalling the anti-torque bracket

[1] *SNOOP* is a registered trade mark of the NUPRO Company, Willoughby, Ohio.

Part 1. Preparations

1-1. Secure the help of another person—two people must be present during this procedure.

1-2. Review the Material Safety Data Sheet for chlorine in Section 2, noting in particular its high toxicity, corrosiveness, and explosive reactivity.

1-3. Review the procedures provided by the site Chemical Safety Officer governing tasks of this nature and prescribing the proper disposition of the "old" Cl_2 cylinder. If no such procedures have been provided, alert the site Chemical Safety Officer that you will be performing this task. If the site does not have a designated Chemical Safety Officer, alert site management personnel (as well as any personnel present in the general area surrounding the FIB system) that you will perform this task, and obtain instructions concerning the proper disposition of the "old" Cl_2 cylinder.

1-4. Identify exits, safety shower, eye wash station, etc. If the site does not provide an eye wash station, a portable eye wash station should be procured.

1-5. Review the layout of the GAE cabinet (see Fig. 1). Note that pushing the illuminated *Pneu Valve Shutdown* push-button switch (light goes off) closes all pneumatic valves in the GAE cabinet. The motorized valve (V17) is not affected by this switch. Notice in Fig. 1 the difference between the *Process Gas* valve (see **1** in Fig. 1) and the *Process Gas Shutoff* valve (see **2** in Fig. 1).

1-6. At the FIB system workstation with the application software program running, select *GAE Control* from the Misc menu to display the Gas Control Popup dialog box (see Fig. 2).

1-7. Make sure that the output pressure of the nitrogen supply cylinder for the GAE cabinet is set for about 30 psig. If it is significantly higher, reduce it to 30 psig now (see step 6-2) and return to Part 2.

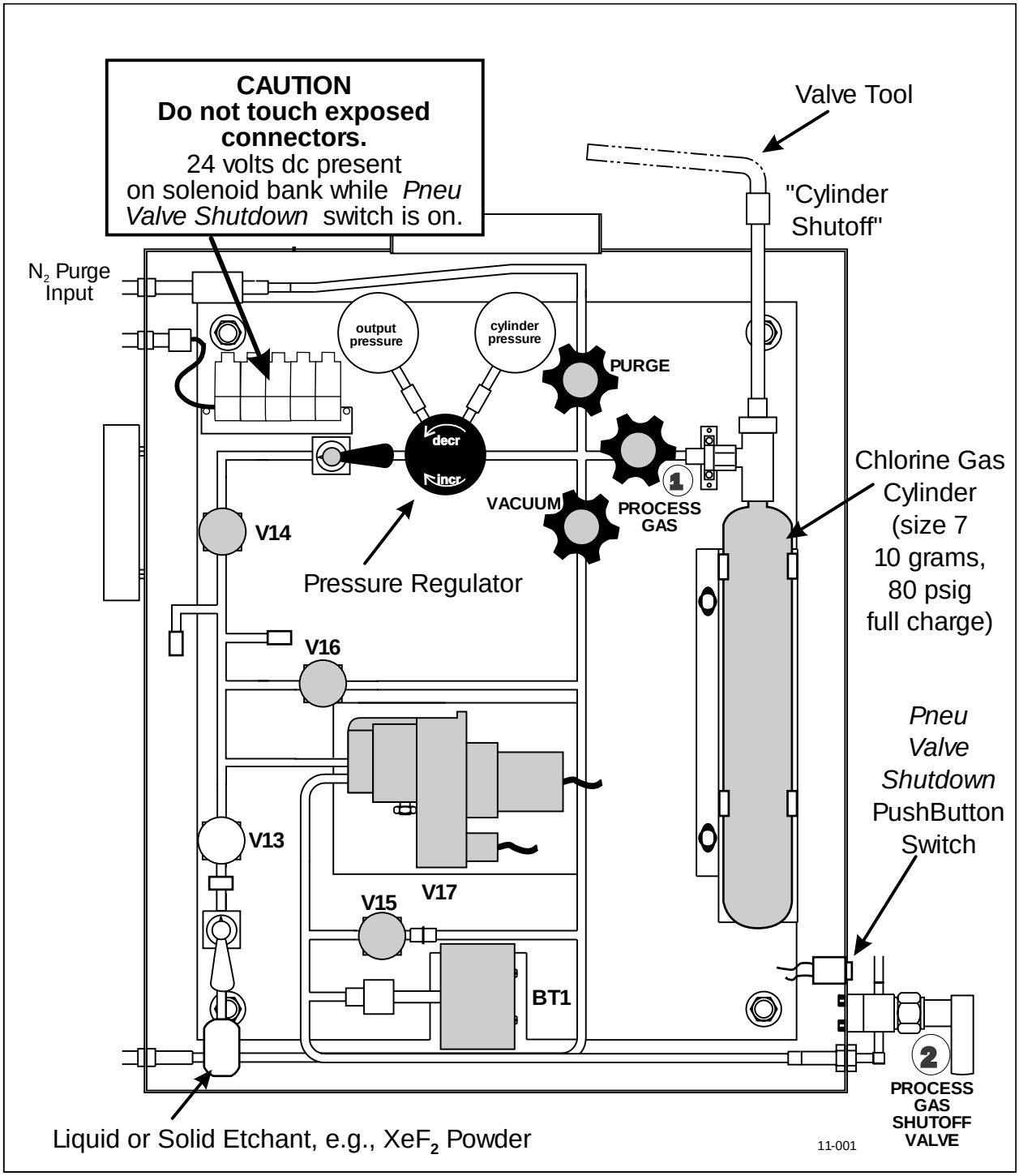


Figure 1. GAE Cabinet Layout with Cl_2.

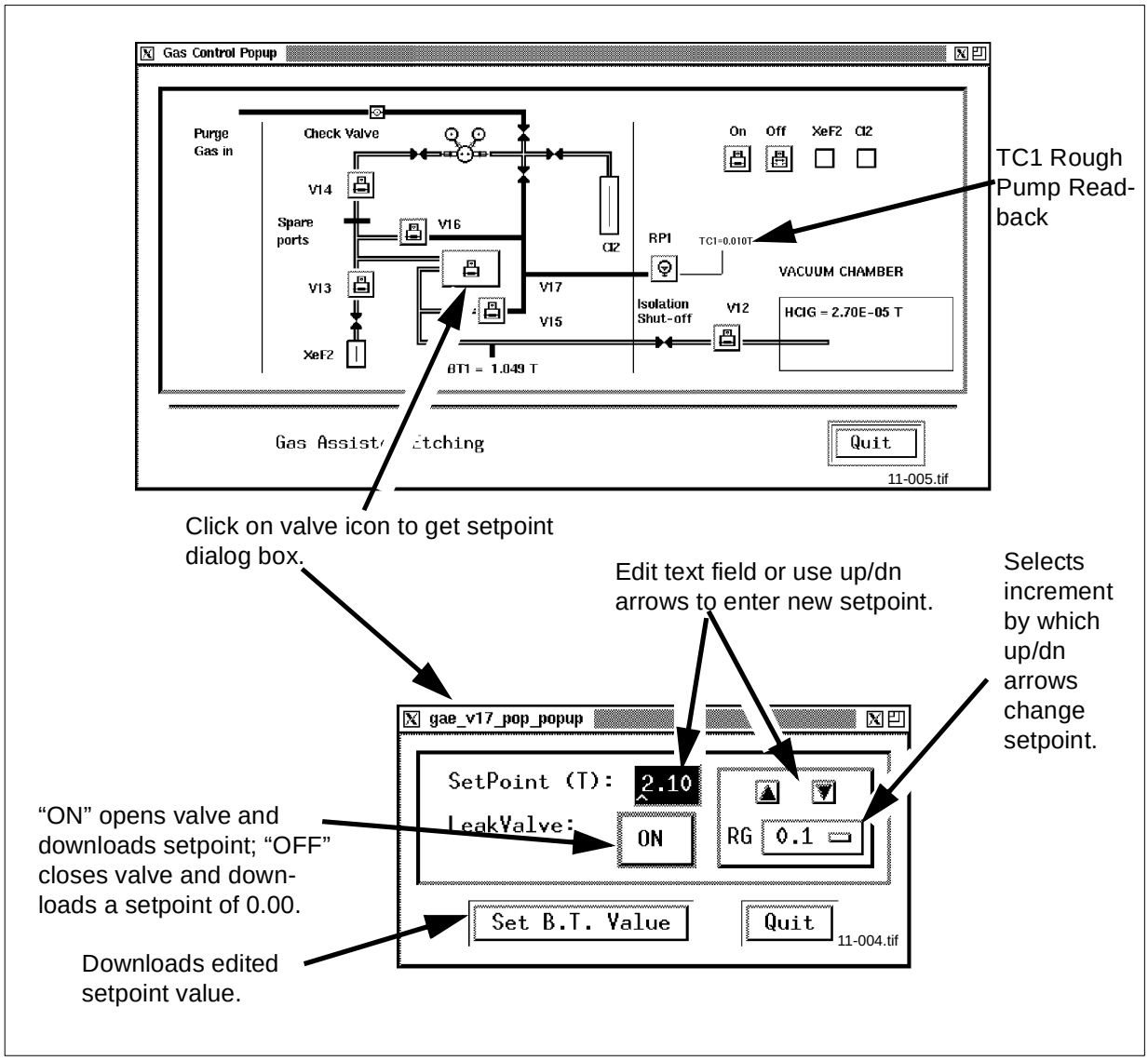


Figure 2. Gas Control Popup Dialog Boxes.

[TC1 updates only while RP1 (rough pump) is activated;

the system updates HCIG and BT1 readouts at all times.]

Part 2. Outline

This section is only an overview. The actual procedure is given in Part 3. Do not use this overview in place of the actual procedure.

2-1. Pump and purge the GAE system lines. (Close the valve on the top of the "old" cylinder first.)

2-2. Remove, plug, and tag the "old" cylinder (post-removal disposition per site policy).

2-3. Inspect and install the "new" cylinder.

2-4. Leak-check the coupling with 100 psig nitrogen and liquid leak-detector.

2-5. Pump and purge the gas lines leading back to the "new" cylinder.

2-6. Reinstitute chlorine gas flow to the FIB system workchamber.

WARNING

Both the "old" and "new" cylinders contain pressurized chlorine gas, which is highly toxic and corrosive. To minimize the risk of potentially fatal exposure, you must follow this procedure exactly.

Part 3. Pump and Purge the GAE System Lines

3-1. Make sure that the GAE cabinet exhaust system is operating correctly. Because the GAE cabinet door will be open, the greater the exhaust flow, the better. If the flow is limited by a gate valve in the exhaust duct, note the position of the gate valve (so that you can restore it later) and then open it fully.[2]

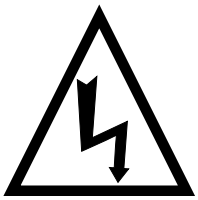
Note: Bypass the safety interlock shut-off switch on the door of the GAE cabinet during this procedure. For systems with this switch, opening the cabinet door with this switch has the same effect as shutting off the Pneu Valve shutoff. The switch shuts off the dc power controlling the pneumatic valves. To bypass the switch with the cabinet door open, press the back of the switch actuator toward you until it clicks into the extended bypass position.

[2] If the duct has a high/low flow sensor, increasing the air flow may cause an alarm condition, which triggers the +24V GAE interlock circuit, disabling valve solenoid power, and may also trigger an audible or visible alarm. If this situation exists, bypass (jumper) the flow sensor. The interlock resets after you clear the alarm condition by using the push-button adjacent to J1104 on the rear panel of the vacuum control unit or by using a remote push-button provided by the customer.

3-2. Make sure that the process module vacuum pump exhaust connections are secure and that the pump exhaust system is operating correctly.

3-3. Make sure that the yellow-green push-button switch labeled *Pneu Valve Shutdown* on the GAE cabinet is illuminated (dc power for controlling the pneumatic valves must be enabled).

CAUTION



When the Pneu Valve Shutdown switch is on, there is a 24 volt, 5 ampere, dc potential present on the exposed connectors on the bank of solenoid-operated valves in the upper left-hand corner of the GAE cabinet. **Do not touch these connectors.** See Fig. 1. Although this presents a relatively minor electric-shock hazard, a short-circuit caused by introducing a conductive metal object such as a tool or a finger ring could generate enough heat energy to cause burns before the power supply automatically switches off. Do not wear finger rings or other jewelry while working in the GAE cabinet. Exercise care when using conductive metal tools.

3-4. At the top of the GAE cabinet there is a valve shutoff tool inserted into the hole labeled *Cylinder Shutoff*. Close the cylinder valve on the "old" cylinder by turning the valve shutoff tool fully clockwise (see Fig. 1). Be sure that the valve is firmly closed. If you use the tool provided, there is no danger of exerting too much torque. After closing the valve, withdraw the valve tool upward (the rubber gasket should retain it) so as to be well clear of the cylinder.

3-5. Close the manual valves on all other chemical reservoirs installed in the GAE cabinet.

3-6. Make sure that valves V12 through V17 are closed.

To open or close any of the pneumatic valves V12 through V16, simply click on the valve's icon in the Gas Control Popup (see Fig. 2). The icon's color and appearance change to show the new state. Valves V13 (XeF_2 reservoir), V19 (Br_2 reservoir), and V14 (Cl_2 reservoir) are interlocked such that only one can be open at a time.

Close V17 by clicking on its valve icon to display the setpoint dialog box; then click on the *LeakValve* toggle-button so that it reads *OFF* (see Fig. 2).

3-7. Click on the RP1 icon in the Gas Control Popup to start the roughing pump.

a. Wait until TC1 shows ≤0.01 torr, then open V15 and wait for BT1 to read base pressure (≅ 0.001 T).

b. When BT1 reads base pressure, record the reading for future reference.

c. Close V15 and close the manual valve labeled *Process Gas Shutoff* on the outside of the GAE cabinet (see Fig. 1).

3-8. In the GAE cabinet, make sure that the chlorine cylinder valve is closed (and not leaking) as follows:

a. Turn the pressure regulator control knob (see Fig. 1) fully clockwise to open the pressure regulator fully.

b. Open the manual valve labeled *Process Gas*.

c. Open the manual valve labeled *Vacuum* to pump out the chlorine delivery line as far as V14. The unlabeled manual valve between the pressure regulator and V14 should remain open.

d. Pump for five minutes.

e. Close the manual valve labeled *Vacuum*.

f. Observe both pressure gauges on the pressure regulator for at least 30 seconds. If the needles remain fully counterclockwise (at -30" Hg), proceed to step 3-9. If they do not, the cylinder valve may not be fully closed, or may be leaking. Make sure that the valve is fully closed and go back to substep *c* above.

WARNING

If the chlorine cylinder valve is not fully closed, or is leaking, you will be exposed to potentially lethal chlorine gas if you disconnect the cylinder coupling. Do not proceed until you are certain that the cylinder valve is not leaking. If the valve leaks even though you believe it is fully closed, contact Micrion Product Support for further advice.

3-9. Purge the chlorine delivery lines as follows:

a. Make sure that V15 is closed. The roughing pump should still be on; if it is not, switch it on and wait at least 30 seconds for TC1 to register ≤ 0.01 torr.

b. In the GAE cabinet, slowly open the manual valve labeled *Purge* (see Fig. 1) to admit nitrogen. When the gauges on the pressure regulator approach 30 psi, close the *Purge* valve. Do *not* exceed 30 psi or you will risk damaging the gauge on the left-hand side of the regulator.

c. Slowly open the manual valve labeled *Vacuum*. Both gauges on the pressure regulator should go to -30" Hg. Wait at least 30 seconds for TC1 to register ≤ 0.01 torr.

d. Open V15.

e. When BT1 indicates base roughing pressure (≅ 0.001 T), close V15 and the manual valve labelled *Vacuum*; one purge cycle is complete.

3-10. Repeat step number 3-9 four times for a total of 5 purge cycles. End with V15 closed and the roughing pump switched off.

Part 4. Remove, Plug, and Tag the Old Cylinder

4-1. In the GAE cabinet (see Fig. 1):

- Close the manual *Vacuum* valve.
- Close the manual *Process Gas* valve.
- Close the unlabeled valve between the pressure regulator and V14.
- Close the pressure regulator by turning the control knob fully counterclockwise.

4-2. Put on rubber gloves and safety glasses and remove the "old" cylinder as follows:

a. Using the 1-1/4" open end wrench, loosen the CGA 660 coupling.

b. Using the appropriate hex key, loosen and remove the front (outer) part of the anti-torque clamp and place it in the bottom of the GAE cabinet.

c. Using the appropriate hex key, loosen the two set screws in the rear (inner) part of the anti-torque clamp and slide the clamp to the left so that the nut on the CGA coupling can be fully loosened.

d. Unscrew the CGA 660 coupling nut completely and carefully remove the cylinder.

e. Screw the protective CGA cap onto the fitting on the "old" cylinder and tighten it securely with the 1-1/4" open end wrench.

f. Place the "old" cylinder temporarily in a secure place for eventual disposition in accordance with local procedures. Be sure that the cylinder is tagged "In Use."

Part 5. Inspect and Install the New Cylinder

5-1. In the GAE cabinet, clean the male end of the CGA 660 fitting with a clean dry wipe.

5-2. Place a new Teflon gasket on the male end of the CGA 660 fitting in the GAE cabinet.

5-3. Use the 1 1/4" open end wrench to make sure that the valve on the "new" cylinder is closed.

DANGER

If the valve has been opened since the cylinder was charged, a potentially lethal amount of chlorine will escape when you remove the CGA cap. If you suspect that the valve has been opened, do not proceed further. Contact the site Chemical Safety Officer and/or Micrion Product Support for further instructions.

5-4. Perform this step under a vented hood or in the vented GAE cabinet: Using the 1-1/4" open end wrench, remove the CGA cap from the "new" cylinder and store the cap in the bottom of the GAE cabinet.

5-5. Inspect the CGA fitting on the cylinder and, if necessary, clean it with a dry swab.

5-6. Place the contaminated cleaning materials, including the used gasket, in a plastic bag for

disposal (in accordance with local procedures).

5-7. Install the "new" cylinder in the GAE cabinet. The CGA 660 coupling (with gasket) should screw together easily by hand; if it does not, adjust the alignment of the cylinder with the gas line assembly. Hand-tighten the coupling; but do not tighten it with the wrench.

5-8. Reinstall and tighten the anti-torque clamp.

5-9. Using the torque wrench with the crowfoot adapter, tighten the CGA fitting to approximately 50 ft.-lbs of torque. Do *not* open the chlorine cylinder valve at this time.

5-10. At the workstation, click on the RP1 icon to switch on the roughing pump. Wait 30 seconds, until TC1 reads ≤ 0.01 torr.

5-11. At the GAE cabinet, open the manual *Vacuum* and *Process Gas* valves to rough-pump the gas lines.

5-12. After at least 30 seconds, when TC1 reads ≤ 0.01 torr, open V15.

5-13. When the BT1 indicates base pressure, close V15 and the manual *Vacuum* valve, and switch the roughing pump off.

WARNING

The chlorine cylinder is pressurized to approximately 80 psig. Do not open the chlorine cylinder valve until you are certain that the CGA 660 coupling does not leak.

Part 6. Leak-check the CGA 660 Coupling

6-1. Perform the leak-check as follows:

a. At the nitrogen supply tank, increase the output pressure to 90 to 100 psig.

b. At the GAE cabinet, open the manual *Purge* valve. The *Process Gas* valve should still be open at this time. The cylinder pressure gauge on the right-hand side of the chlorine pressure regulator should read 85 to 95 psig.

c. Apply a small amount of the liquid leak-detector to the CGA coupling and check for bubbles. If a leak is indicated by the presence of bubbles, close the *Purge* valve and the *Process Gas* valve, disconnect the CGA coupling and clean or replace the gasket. Then resume this procedure at step number 5-7.

Do not proceed until you have a leak-free connection.

6-2. After establishing that there is a leak-free connection with the nitrogen supply at 90 to 100 psig, restore the output pressure at the nitrogen supply cylinder to 30 psig as follows:

a. At the nitrogen supply cylinder, turn the nitrogen pressure regulator knob fully counterclockwise, turn the regulator fully off, and then close the output valve on the nitrogen pressure regulator.

b. At the workstation, switch on the roughing pump for at least 30 seconds, until TC1 reads ≤ 0.01 torr.

c. In the GAE cabinet, open the manual *Vacuum* valve very slowly to bleed the pressurized nitrogen through the roughing pump.

d. When the right-hand gauge on the chlorine pressure regulator reads -30" Hg, close the manual *Vacuum* valve.

e. At the nitrogen cylinder, open the output valve on the nitrogen pressure regulator.

f. Slowly open the nitrogen pressure regulator (turn the knob clockwise) until the output pressure gauge reads 30 psig.

g. In the GAE cabinet, observe that the right-hand gauge on the chlorine pressure regulator reads 25 to 30 psig. Close the manual *Purge* valve.

Part 7. Purge the Chlorine Delivery Lines

7-1. At the GAE cabinet, purge the chlorine delivery lines as follows:

a. The roughing pump should still be on; if it is not, switch it on and wait at least 30 seconds for TC1 to register ≤ 0.01 torr. The manual valve *Vacuum* should be closed.

b. In the GAE cabinet, slowly open the manual valves labeled *Purge* and *Process Gas* to admit nitrogen. When the right-hand gauge on the chlorine pressure regulator approaches 30 psi, close the *Purge* valve.

c. Slowly open the manual valve labeled *Vacuum*.

d. Wait at least 30 seconds for TC1 to register ≤ 0.01 torr, and then open V15.

e. When BT1 indicates base pressure (≅ 0.001 T) close V15 and the manual valves labeled *Process Gas* and *Vacuum*. One purge cycle is complete.

7-2. Repeat step 3-287 four times for a total of 5 purge cycles. End with V15 closed, the manual *Vacuum* and *Process Gas* valves closed, and the roughing pump on.

7-3. In the Gas Control Popup, open valves V14, V15 and V16.

7-4. On the outside of the GAE cabinet, open the manual *Process Gas Shutoff* valve.

7-5. In the GAE cabinet, open the unlabeled manual valve between the chlorine pressure regulator and V14. Wait for BT1 to indicate base pressure (≅ 0.001 T). Do *not* open the chlorine pressure regulator at this time.

7-6. In the Gas Control Popup, close valves V14, V15, and V16. Close the unlabeled manual valve between V14 and the Cl_2 pressure regulator.

Part 8. Reinstitute the Chlorine Gas Flow

8-1. Using the 3/8" open end wrench (at least 10-12" long), open the chlorine cylinder valve, located on the top of the cylinder, one half turn counterclockwise. (Considerable torque is required to open the cylinder valve initially. Anchor the cylinder with your free hand as best you can to minimize the torque load placed on the CGA 660 fitting. Thereafter, the valve tool provided with the GAE cabinet can be used for opening and closing the valve.)

DANGER

If an accident should occur that results in the release of chlorine, close the GAE cabinet door as quickly as possible. Do not continue with this procedure. Evacuate all personnel from the area and notify the site's Chemical Safety Officer or other responsible management personnel immediately.

8-2. In the GAE cabinet, open the manual *Process Gas* valve and observe the input pressure gauge on the right-hand side of the pressure regulator. It should read approximately 80 psi.

8-3. Slowly turn the control knob on the pressure regulator clockwise until the output pressure gauge (on the left-hand side of the regulator) reads about -20" Hg.

8-4. Open the unlabeled manual valve between V14 and the pressure regulator, and readjust the pressure regulator as necessary to obtain -20" Hg.

8-5. Close the chlorine cylinder valve with the valve tool provided with the GAE cabinet.

8-6. Close the manual *Process Gas* valve.

8-7. Close the GAE cabinet.[3]

8-8. In the Gas Control Popup, open valve V14.

8-9. In the Gas Control Popup, set up V17 as follows:

a. Click on the V17 icon to obtain the setpoint dialog box.

b. Enter a setpoint value of 1.0 (T).

c. Click on the *LeakValve* toggle-button so that it reads *on* (V17 valve open).

d. Wait for BT1 to settle at about 1 torr.

8-10. Open valve V12 to admit chlorine to the workchamber. Observe the BT1 readback to make sure that it continues to register 1 torr, indicating that the chlorine flow is properly regulated.

8-11. Close valves V17 and V14. (To close V17, click on the valve icon to obtain the setpoint dialog box, then click on the *LeakValve* toggle-button so that it reads *OFF*.)

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[3] Whether or not the GAE cabinet should be locked, and who shall have custody of keys, may be governed by site safety policy.

8-12. Switch on the roughing pump for at least 30 seconds until TC1 reads ≤ 0.01 torr, then open valves V15 and V16 to remove chlorine from the common delivery lines. When BT1 registers base pressure (≅ 0.001 T), close V15 and V16, and switch off the roughing pump.

8-13. Remove the bypass for the shut-off safety interlock switch on the GAE cabinet door.

8-14. Restore GAE cabinet ventilation to the normal flow rate by adjusting the gate valve.[4]

8-15. Open the manual valves on the other chemical reservoirs installed in the GAE cabinet.

[4] If you jumpered the high/low flow sensor, be sure to remove the jumper after the correct flow is restored.

Micrion

Service Procedure No.: **11-02**
Service Procedure Title: **Xenon Difluoride Cylinder Replacement**
Applicable Systems: **All Systems w/ XeF_2**
Frequency of Service: **As Needed**

Introduction

Do not undertake this procedure without prior training and authorization by Micrion Corporation. Do not use this document as a substitute for that training. Normally, only Micrion service personnel perform this procedure.

This document has four parts: (1) preparations, (2) a general outline of the procedure, (3) the procedure itself, and (4) the Material Safety Data Sheet for xenon difluoride (XeF_2) in Section 2.

Tools and Materials Required

- The "new" XeF_2 cannister assembly, part number 100-009040 (see Fig. 1)
- 2 new VCR[1] gaskets, including a solid plug for the "old" cannister
- Rubber gloves and safety glasses
- Dry wipes and lint-free swabs for cleaning
- Disposal bag for contaminated waste (used wipes, gaskets, etc.)
- 3/4" open end wrench
- 5/8" open end wrench
- 5/32" hex key.

NOTICE

Per paragraph 11.1 of Safety Guidelines for Semiconductor Manufacturing Equipment (S2-93), this procedure is a Type 3 task. Specifically: "Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are less than 30 volts RMS, 42.2 volts peak, 240 volt-amps, and 20 Joules."

NOTICE: When opened, the valve handle points down, toward the cannister.

[1] *VCR* is a registered trade mark of the Cajun Company, Macedonia, Ohio.

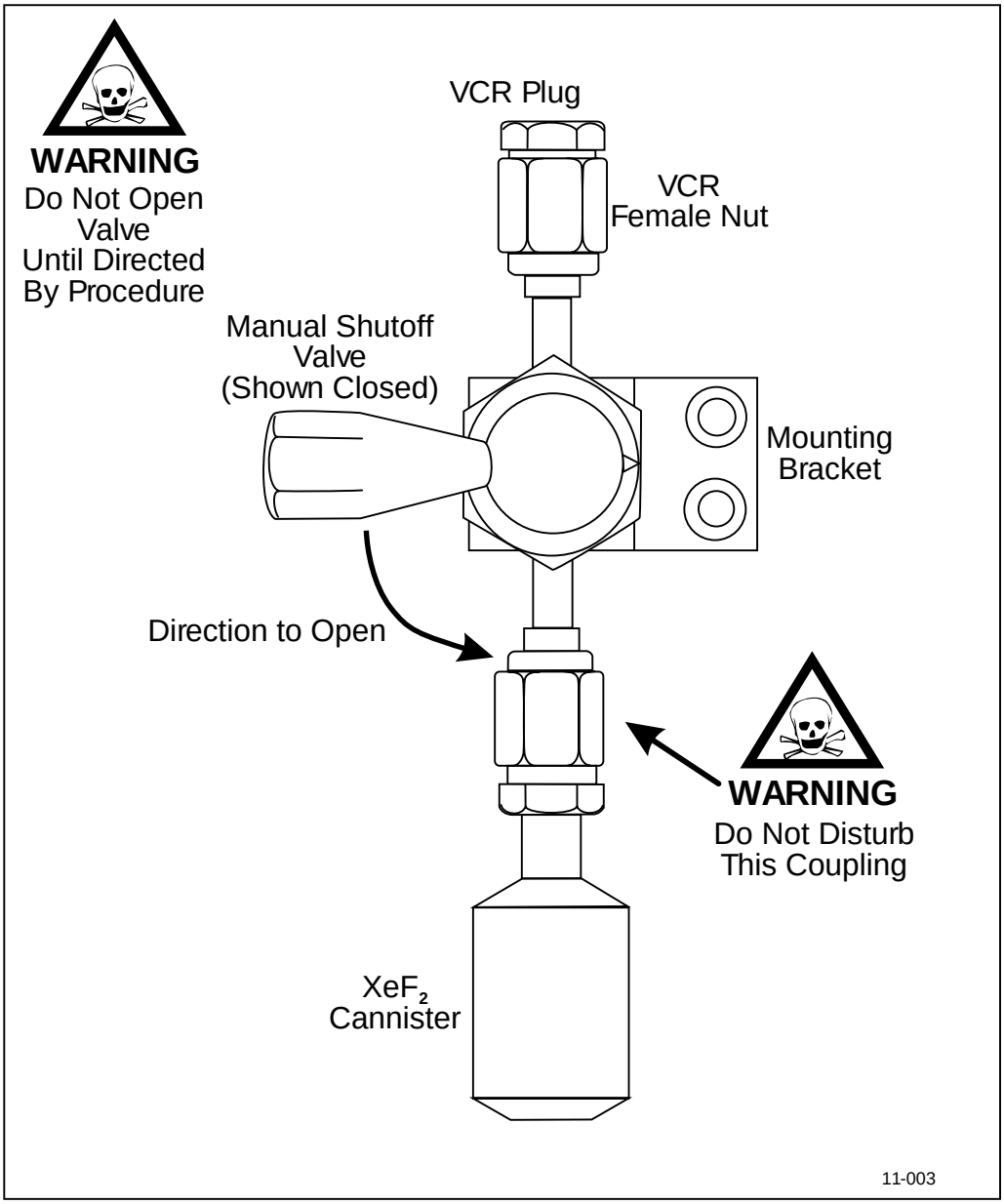


Figure 1. Xenon Difluoride Cannister Assembly, part no. 100-009040.

Part 1. Preparations

1-1. Secure the help of another person—two people should be present during this procedure.

1-2. Review the Material Safety Data Sheet for xenon difluoride in Section 2.

1-3. Review the procedures provided by the site Chemical Safety Officer governing tasks of this nature. If no such procedures are provided, alert the site Chemical Safety Officer that you will be performing this task. If the site does not have a designated Chemical Safety Officer, alert site management personnel (as well as any personnel present in the general area surrounding the FIB system) that you will be performing this task.

1-4. Identify exits, safety shower, eye wash station, etc. If the site does not provide an eye wash station, a portable eye wash station should be procured.

1-5. Assemble the materials.

1-6. Review the layout of the GAE cabinet (see Fig. 2).

Pushing the illuminated *Pneu Valve Shutdown* push-button switch (light goes off) closes all pneumatic valves in the GAE cabinet by removing the 24 volt dc power from the solenoid bank. The motorized valve (V17) is not affected by this switch.

1-7. At the FIB system workstation, with the application software program running, pull down the Gas menu and click on *GAE Control* to obtain the Gas Control Popup dialog box (see Fig. 3).

Part 2. Overview

This section is only an overview. Do not use this overview in place of the actual procedures.

2-1. Pump and purge GAE system lines. Close the manual shutoff valve on the "old" XeF_2 cannister assembly, and rough-pump the gas lines leading back to it.

2-2. Remove, plug, and tag the "old" cannister to be sent back to Micrion.

2-3. Inspect and install the "new" XeF_2 cannister assembly.

2-4. Pump the gas lines leading back to the "new" XeF_2 cannister.

2-5. Reinstitute XeF_2 gas flow to the FIB system workchamber.

WARNING

Both the "old" and "new" cannisters contain xenon difluoride, a strong irritant that may be harmful if inhaled, ingested, or absorbed through the skin. The GAE cabinet may also contain a cylinder of chlorine gas, which is highly toxic. To minimize the risk of exposure to these chemicals, you must follow this procedure exactly.

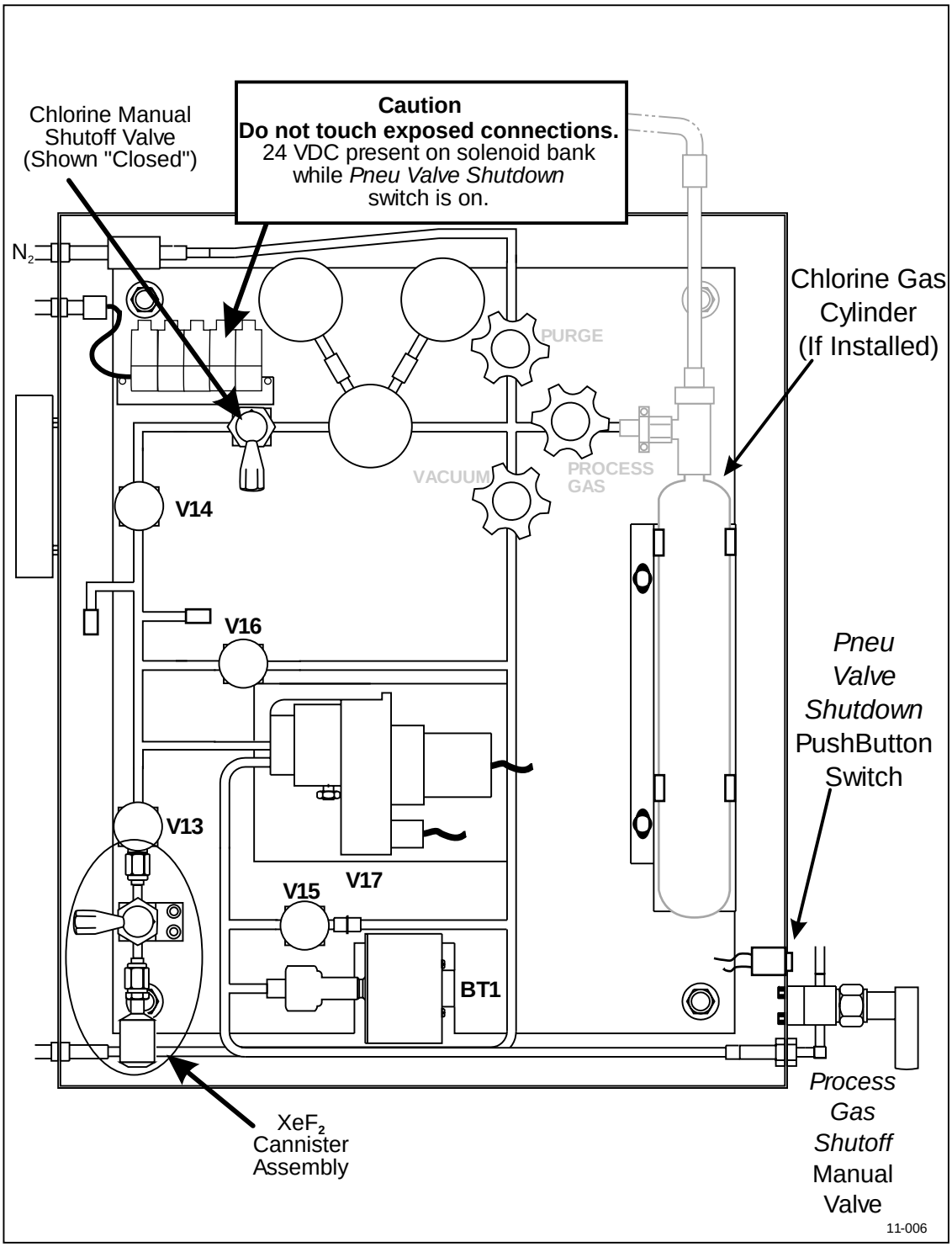


Figure 2. GAE Cabinet Layout with XeF_2

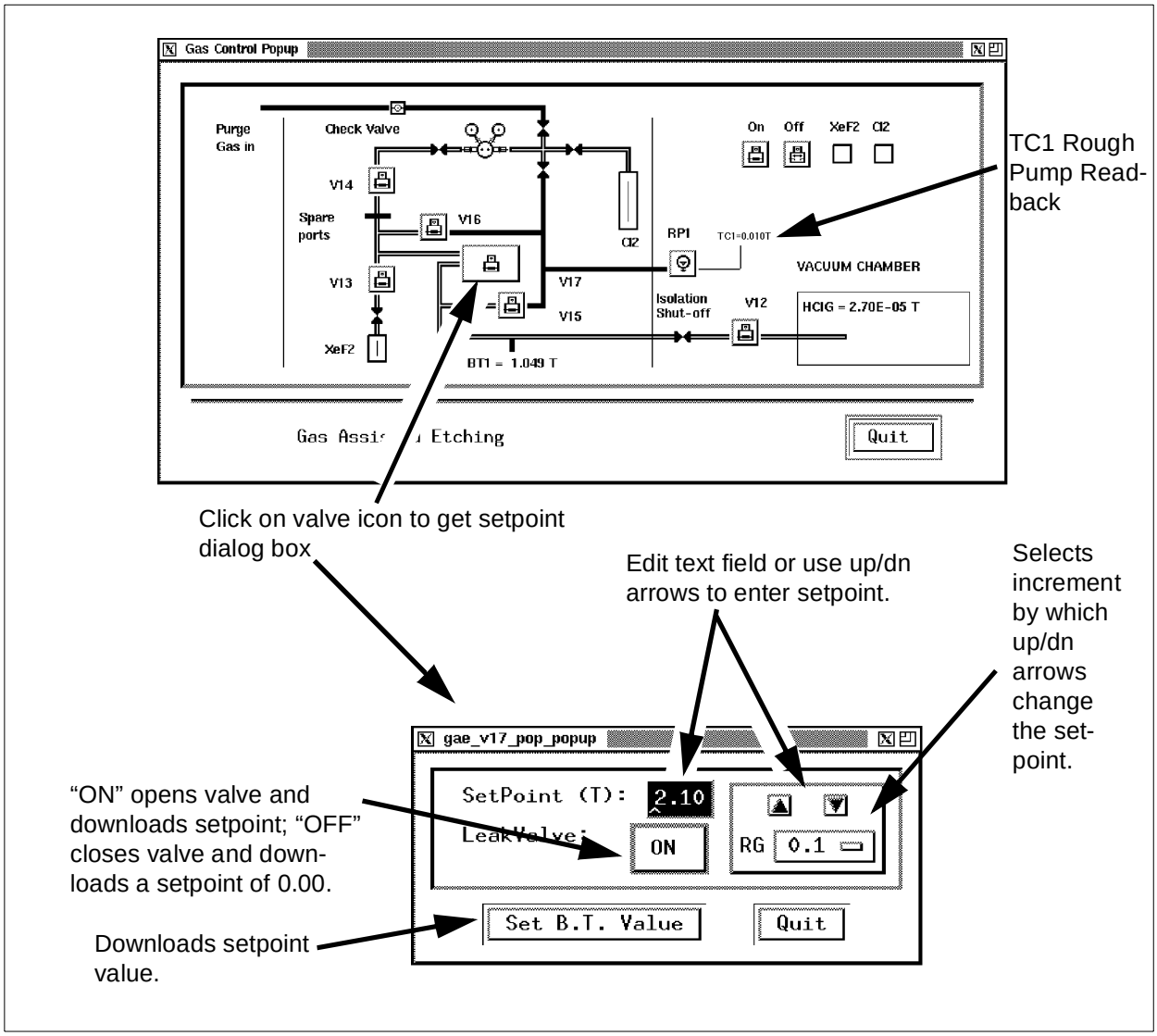


Figure 3. Gas Control Popup Dialog Boxes

NOTICE: The system updates TC1 only while RP1 is activated; the system updates cathode ion gauge and BT1 readouts continually.

Part 3. Pump and Purge GAE System LInes

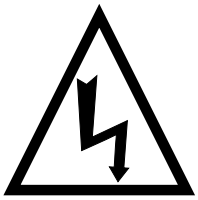
3-1. Make sure that the GAE cabinet exhaust system is operating correctly. Because the GAE cabinet door will be open, the greater the exhaust flow the better. If the flow is limited by a gate valve in the exhaust duct, note the position of the gate valve (so that you can restore it later) and then open it fully.[2]

If the system has the cabinet door safety interlock shut-off switch, bypass it during this procedure. Opening the cabinet door has the same effect as shutting off the *Pneu Valve Shutdown*: it shuts off the dc power controlling the pneumatic valves. To bypass the switch with the cabinet door open, press the back of the switch actuator toward you until it clicks into the extended bypass position.

3-2. Make sure that the process module vacuum pump exhaust connections are secure and that the pump exhaust system is operating correctly.

3-3. Make sure that the pushbutton switch labeled *Pneu Valve Shutdown* on the GAE cabinet is illuminated (dc power for controlling the pneumatic valves must be enabled) at this time.

CAUTION



When the Pneu Valve Shutdown switch is on, there is a 24 volt, 5 ampere, dc potential present on the exposed connectors on the bank of solenoid-operated valves in the upper left-hand corner of the GAE cabinet. **Do not touch these connectors.** See Fig. 1. Although this presents a relatively minor electric-shock hazard, a short-circuit caused by introducing a conductive metal object such as a tool or a finger ring could generate enough heat energy to cause burns before the power supply automatically switches off. Do not wear finger rings or other jewelry while working in the GAE cabinet. Exercise care when using conductive metal tools.

3-4. If the GAE cabinet has chlorine installed, close the unlabeled manual valve between the Cl_2 pressure regulator and valve V14 by turning it 1/4 turn clockwise as shown in Fig. 2.

3-5. Close the manual valves on all other chemical reservoirs installed in the cabinet.

3-6. Make sure that all valves V12 through V17 are closed.

To open or close any of the pneumatic valves V12 through V16, simply click on the valve's icon in the Gas Control Popup (see Fig. 3). The icon's color and its appearance change to show the new state (open or closed). Valves V13 (XeF_2 reservoir), V19 (Br_2 reservoir), and V14 (Cl_2 reservoir) are interlocked so that only one can be open at a time.

To close V17, click on the valve icon to obtain the setpoint dialog box, then click on the

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[2] If the duct has a high/low flow sensor, increasing the air flow may cause an alarm condition, which triggers the +24V GAE interlock circuit, disabling valve solenoid power, and may also trigger an audible or visible alarm. If this situation exists, bypass (jumper) the flow sensor. The interlock resets after you clear the alarm condition by using the push-button adjacent to J1104 on the rear panel of the vacuum control unit or by using a remote push-button provided by the customer.

LeakValve toggle button so that it reads *OFF* (see Fig. 3).

3-7. Click on the *RP1* icon to start the roughing pump.

a. Wait until TC1 reads ≤ 0.01 torr then open valves V15 and V16.

b. Wait for BT1 to read base pressure (≅ 0.00 torr).

c. When BT1 reads base pressure, record the reading for future reference.

d. Close V15 and the manual valve labeled *Process Gas Shutoff* on the outside of the GAE cabinet (see Fig. 2).

3-8. In the GAE cabinet, close the manual valve on the "old" Br_2 cannister assembly by turning it 1/4 turn clockwise (see Fig. 1).

3-9. In the Gas Control Popup, with valves V15 and V16 still open, open valve V19, and wait for BT1 to indicate base pressure.

3-10. Close valves V19, V15, and V16, and switch off the roughing pump.

Part 4. Remove, Plug, and Tag the Old Cylinder

4-1. Put on the rubber gloves and safety glasses and remove the "old" XeF_2 cannister assembly as follows (see Fig. 1):

4-2. Using the 3/4" and 5/8" open end wrenches, loosen the female VCR nut between valve V13 and the 1/4 turn manual valve. Finish unscrewing the nut by hand.

4-3. Using the hex key, loosen and remove the two socket head cap screws holding the cannister assembly against the mounting plate and remove the assembly from the cabinet.

4-4. Install the solid (no hole) VCR gasket on the "old" reservoir assembly.

4-5. Remove the plastic protective cap from the "old" VCR plug and screw the plug into the female VCR nut on the top of the "old" cannister assembly. Snug it finger-tight, and then, using the 3/4" and 5/8" open-end wrenches, tighten it exactly 1/8 turn.

4-6. Tag the "old" cannister assembly to properly identify its contents. Include the serial number of the FIB system from which it was removed, and the date. Put it temporarily in a secure place for disposition in accordance with local procedures.

4-7. At V13 in the GAE cabinet, clean the male end of the VCR fitting with a clean dry wiper.

Part 5. Install and Inspect the New Cylinder

5-1. On the "new" cannister assembly, make sure that the manual valve is in the *OFF* position.

WARNING

If you remove the VCR® plug from the cannister assembly while the manual valve is open, you will be exposed to xenon difluoride vapor. Do not proceed until you make sure that the valve is closed.

5-2. Perform this step under a vented hood or in the vented GAE cabinet: Using both the 3/4" and 5/8" open-end wrenches, loosen and remove the VCR plug from the female nut at the top of the "new" cannister assembly. Place the plastic protective cap on the VCR plug, and store the plug in the bottom of the GAE cabinet.

5-3. Place a new VCR gasket on the "new" XeF_2 cannister assembly.

5-4. Using the two socket head cap screws and the 5/32" hex key, mount the "new" cannister assembly. Do *not* tighten the cap screws yet.

5-5. Make up the VCR coupling by hand, adjusting the position of the cannister assembly as necessary. Snug the coupling finger-tight.

5-6. Using the 3/4" and 5/8" open-end wrenches, tighten the female VCR nut exactly 1/8 turn.

5-7. Lightly tighten the socket head cap screws. *Do not open* the manual valve on the XeF_2 cannister assembly yet.

Part 6. Pump Down the Gas Lines

6-1. Pump down the gas line between the 1/4-turn manual valve on the XeF_2 cannister and valve V13. Leak-check the VCR coupling as follows:

6-2. Switch on the roughing pump, wait at least 30 seconds until TC1 reads ≤ 0.01 torr, then open valves V13, V15, and V16.

6-3. Open V17 as follows: go to the electronics module and, at the control panel for the MKS 244 pressure/flow controller for V17,[3]Locate the valve mode selector switch (see Fig. 4) on the right-hand end of the controller; rotate the switch counterclockwise from the EXT position to the manual control position, and lift the adjacent toggle switch to the OPEN position.

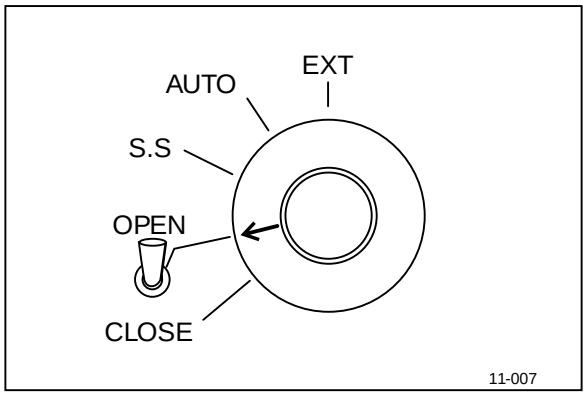

Figure 4. Valve Mode Switch (MKS 244 Pressure/Flow Controller).

6-4. When BT1 indicates base pressure, close V15 and V16. Be sure to leave V13 open.

6-5. Watch BT1 for a rise in pressure, which indicates a leak. If a leak is indicated by a rise in BT1, close valve V13, and then disconnect the VCR coupling, clean it, and clean or replace the gasket. Do not proceed until you have a leak-free connection.

6-6. Open the manual *Process Gas Shutoff* valve on the outside of the GAE cabinet.

6-7. Open V15 and V16 for final pumpdown to base pressure.

[3] If there is more than one MKS controller, the controller for V17 may be identified by a strip of yellow cable-marker tape.

6-8. With valves V12, V13, V15, and V16 closed, reactivate valve V17 as follows:

a. In the Gas Control Popup, click on the valve V17 icon to obtain the setpoint dialog box, and make sure that the *LeakValve* toggle button reads *OFF.*

b. At the control panel for the MKS 244 pressure/flow controller, locate the valve mode selector switch on the right-hand end of the controller (see Fig. 4).

c. Rotate the switch clockwise to the EXT position, and move the toggle switch to its middle position.

6-9. Open the manual valve on the XeF_2 cannister assembly by turning the unlabeled manual valve 1/4 turn counterclockwise.

6-10. Open valve V13.

6-11. In the setpoint dialog box for V17, type in a setpoint of *1.00* and then click on the *Leak-Valve* toggle button so that it reads ON.

6-12. Open valve V12 to begin admitting gas to the workchamber. Observe the BT1 readback; it should continually register 1 torr, indicating that the gas flow is being properly regulated.

6-13. Close valves V12, V13, and V17.

6-14. Remove XeF_2 from the common delivery lines using the following steps:

a. Switch on the roughing pump and wait 30 seconds until TC1 reads ≤0.01 torr.

b. Open valves V15 and V16.

c. Wait until BT1 registers base pressure.

d. Close V15 and V16.

e. Switch off the roughing pump.

6-15. If chlorine and/or bromine are installed, open the manual valve between V14 and the pressure regulator for the chlorine, and the V19 and the manual valve for the bromine.

6-16. Restore GAE cabinet ventilation to the normal flow rate by adjusting the gate valve.[4]

6-17. Remove the bypass for the shut-off safety interlock switch on the GAE cabinet door.

6-18. Close the GAE cabinet.[5]

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[4] If you jumpered the high/low flow sensor, be sure to remove the jumper after the correct flow is restored.

[5] Whether or not the GAE cabinet should be locked, and who shall have custody of keys, may be governed by site safety policy.

Micrion

Service Procedure No.: **11-03**
Service Procedure Title: **Bromine (Br_2) Cylinder Replacement**
Applicable Systems: **All Systems w/ Br_2**
Frequency of Service: **As Needed**

Introduction

Do not undertake this procedure without prior training and authorization by Micrion Corporation. Do not use this document as a substitute for that training. Normally, only Micrion service personnel perform this procedure.

This document has four parts: (1) preparations, (2) a general outline of the procedure, (3) the procedure itself, and (4) the Material Safety Data Sheet for bromine (Br_2) in Section 2.

Materials Required

- Chemical-resistant gloves
- Safety glasses
- VCR plug for “old” cannister (normally in the bottom of the GAE cabinet)
- Two new VCR gaskets
- Lint-free wipes and lint-free swabs
- Disposal bag for contaminated waste (used wipes, gaskets, etc.)
- 3/4" open end wrench
- 5/8" open end wrench
- 5/32" hex key

NOTICE

Per paragraph 11.1 of Safety Guidelines for Semiconductor Manufacturing Equipment (S2-93), this procedure is a Type 3 task. Specifically:
“Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are less than 30 volts RMS, 42.2 volts peak, 240 volt-amps, and 20 Joules.”

Part 1. Preparations

1-1. Secure the help of another person—two people should be present during this procedure.

1-2. Review the Material Safety Data Sheet for Bromine (Br2) in Section 2.

1-3. Review the procedures provided by the site Chemical Safety Officer governing tasks of this nature and prescribing the proper disposition of the "old" Br_2 cannister assembly. If no such procedures have been provided, alert the site Chemical Safety Officer that you will be performing this task. If the site does not have a designated Chemical Safety Officer, alert site management personnel (as well as any personnel present in the general area surrounding the FIB system) that you will perform this task, and obtain instructions concerning the proper disposition of the "old" Br_2 cannister assembly.

1-4. Identify exits, safety shower, eye wash station, etc. If the site does not provide an eye wash station, a portable eye wash station should be procured.

1-5. Assemble the required materials, listed on page 1, along with the "new" Br_2 cannister assembly, part no. 100-010130 (see 1)

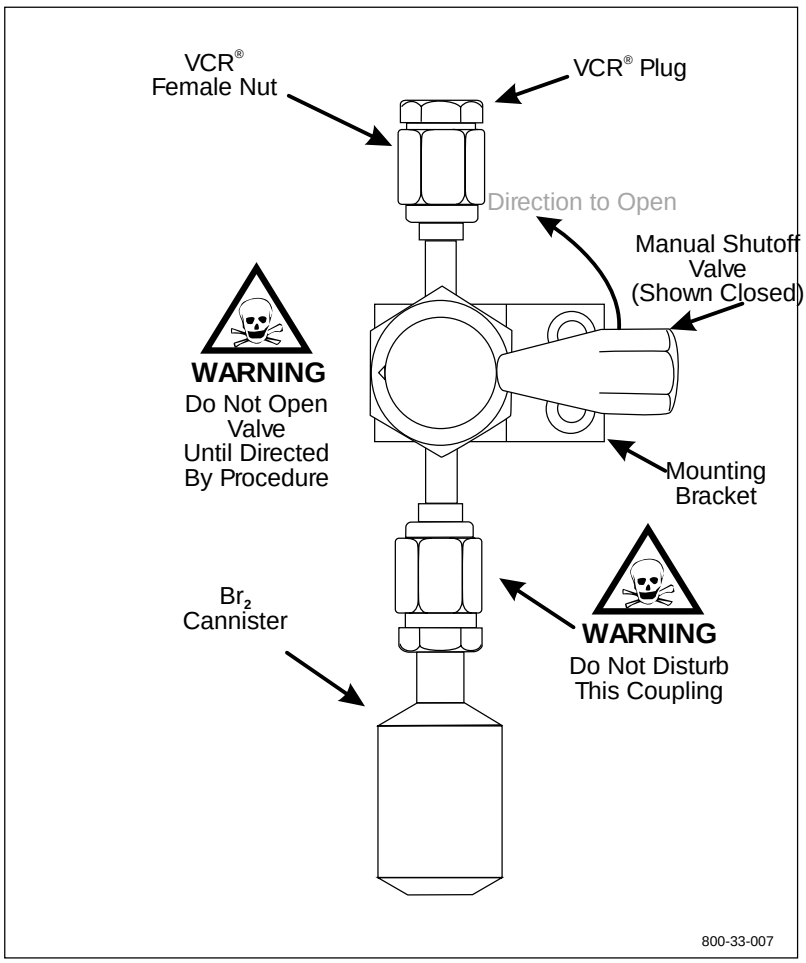


Figure 1. Br_2 Cannister Assembly.

[When opened, valve direction-of-flow points towards the cannister.]

1-6. Review the layout of the GAE cabinet (see 2).

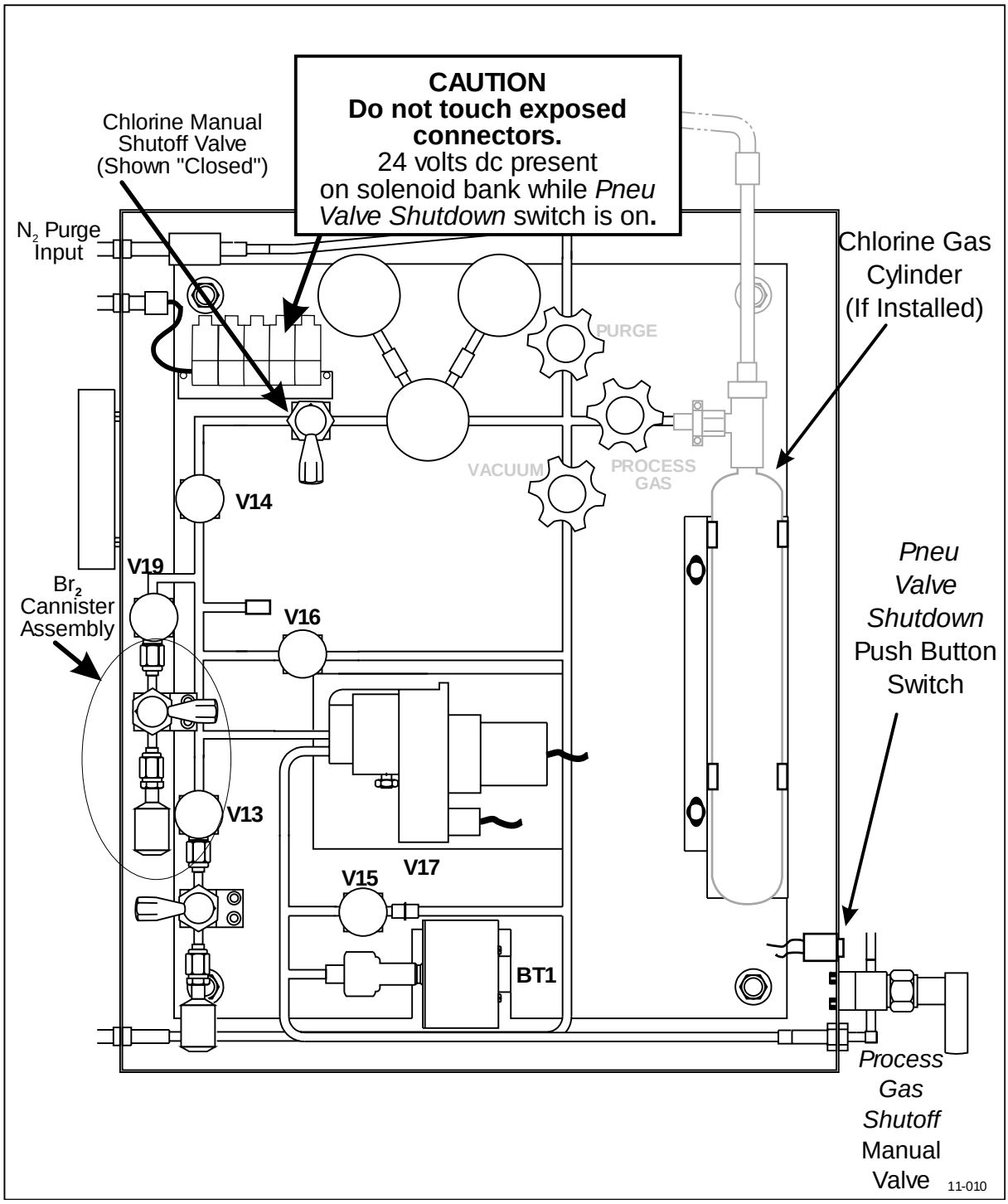


Figure 2. GAE Cabinet Layout with Br_2.

Pushing the illuminated *Pneu Valve Shutdown* push-button switch (light turns off) closes all pneumatic valves in the GAE cabinet by removing the 24 volt dc power from the solenoid bank. The motorized valve, V17, is not affected by this switch.

1-7. At the FIB system workstation, with the application software program running, select *GAE Control* from the Misc pull down menu to display the Gas Control Popup dialog box (see 3).

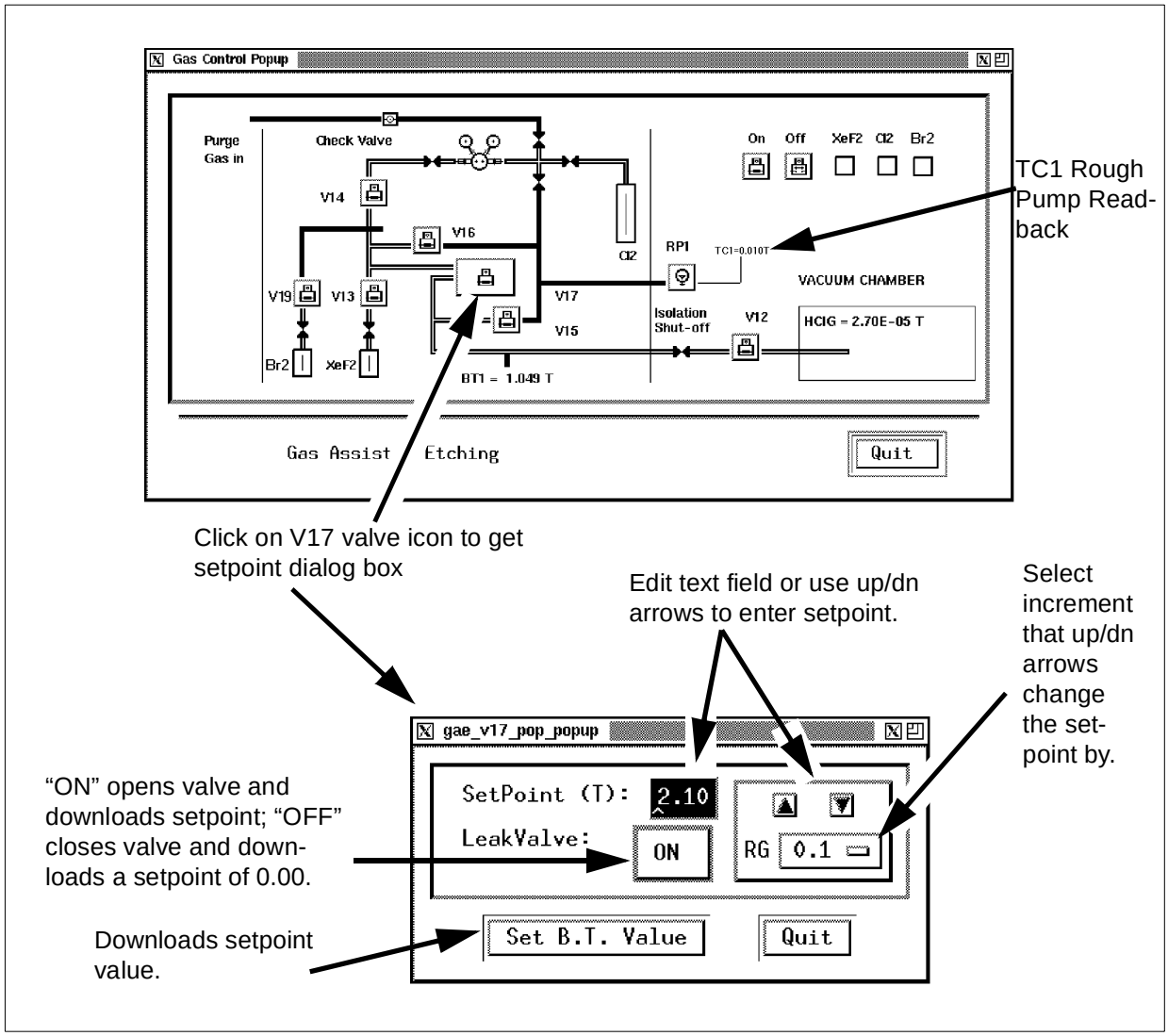


Figure 3. Gas Control Popup Dialog Boxes.

[Note: The system updates TC1 only while RP1 is activated; the system updates HCIG and BT1 readouts at all times.]

NOTICE: PURGE CHLORINE LINE FIRST

If a Chlorine cannister is present in the gas cabinet, be sure to purge the chlorine gas line as described in Service Procedure 11-03 before purging the XeF_2 line.

Part 2. Overview

This section is an overview of this maintenance task. This procedural overview does not include safety warnings. Do not use this overview in place of the actual procedures.

2-1. Pump and purge the GAE system lines. Close the manual shutoff valve on the "old" Br_2 cannister assembly, and rough-pump the gas lines leading back to it.

2-2. Remove, plug, and tag the "old" Br_2 cannister; dispose of the cannister per site policy).

2-3. Inspect and install the "new" Br_2 cannister assembly.

2-4. Pump the gas lines leading back to the "new" Br_2 cannister.

2-5. Reinstitute Br_2 gas flow to the FIB system workchamber.

WARNING

Both the "old" and "new" cannisters contain Br2, a strong irritant that may otherwise be harmful if inhaled, ingested, or absorbed through the skin. The GAE cabinet may also contain a cylinder of chlorine gas, which is highly toxic. To minimize the risk of exposure to these chemicals, you must follow this procedure exactly.

Part 3. Pump and Purge GAE System LInes

3-1. Make sure that the GAE cabinet exhaust system is operating correctly. Because the GAE cabinet door is open during the procedure, the greater the exhaust flow, the better. If the flow is limited by a gate valve in the exhaust duct, note the position of the gate valve (so that you can restore it later) and then open it fully.[1]

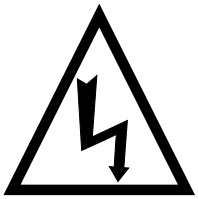
Bypass the safety interlock shut-off switch on the door of the GAE cabinet during this procedure. For systems with this switch, opening the cabinet door has the same effect as shutting off dc power controlling the pneumatic valves. To bypass the switch with the cabinet door open, press the back of the switch actuator toward you until it clicks into position.

3-2. Make sure that the process module vacuum pump exhaust connections are secure and that the pump exhaust system is operating correctly.

3-3. Make sure that the push-button switch labeled *Pneu Valve Shutdown* on the GAE cabinet is illuminated (dc power for controlling the pneumatic valves must be enabled).

[1] If the duct has a high/low flow sensor, increasing the air flow may cause an alarm condition, which triggers the +24V GAE interlock circuit, disabling valve solenoid power, and may also trigger an audible or visible alarm. If this situation exists, bypass (jumper) the flow sensor. The interlock resets after you push the button adjacent to J1104 on the rear panel of the vacuum control unit.

CAUTION



When the Pneu Valve Shutdown switch is on, there is a 24 volt, 5 ampere, dc potential present on the exposed connectors on the bank of solenoid-operated valves in the upper left-hand corner of the GAE cabinet. **Do not touch these connectors.** See Fig. 1. Although this presents a relatively minor electric-shock hazard, a short-circuit caused by introducing a conductive metal object such as a tool or a finger ring could generate enough heat energy to cause burns before the power supply automatically switches off. Do not wear finger rings or other jewelry while working in the GAE cabinet. Exercise care when using conductive metal tools.

3-4. Purge the chlorine line before continuing (see Service Procedure 11-01).

3-5. Close the manual valve on all other chemical reservoirs installed in the GAE cabinet.

3-6. Make sure that all valves V12 through V17 and V19 are closed.

To open or close any of the pneumatic valves V12 through V16, simply click on the valve's icon in the Gas Control Popup (see 3). Valves V13 (XeF_2 reservoir), V19 (Br_2 reservoir), and V14 (Cl_2 reservoir) are interlocked; only one can be open at a time.

To close valve V17, click on the valve icon to obtain the setpoint dialog box, then click on the *LeakValve* toggle button so that it reads *OFF* (see 3).

3-7. Click on the RP1 icon to start the roughing pump.

a. Wait until TC1 reads ≤ 0.01 torr, then open valves V15 and V16.

b. Wait for BT1 to read base pressure (≅ 0.001 torr).

c. When BT1 reads base pressure, record the reading for future reference.

d. Close the valve labeled *Process Gas Shutoff* outside the GAE cabinet (see 2).

3-8. In the GAE cabinet, close the manual valve on the "old" Br_2 cannister assembly by turning it clockwise (see 1).

3-9. In the Gas Control Popup, with valves V15 and V16 still open, open valve V13, and wait for BT1 to indicate base pressure.

3-10. Switch off the roughing pump.

3-11. Purge and vent the system three times in a row, using the nitrogen that is now in the chlorine line (see step 3-4):

a. Open the DN_2 valve until BT1 = 9.970

b. Close DN_2 and switch on the roughing pump.

c. When BT1 = base pressure, switch off the roughing pump.

d. Repeat *a-c* twice more.

Part 4. Remove, Plug, and Tag Old Cylinder

4-1. Put on the rubber gloves and safety glasses and remove the "old" Br_2 cannister assembly:

4-2. Using the 3/4" open end wrench, loosen the female VCR nut between valve V19 and the manual 1/4 turn valve. Finish unscrewing the nut by hand.

4-3. Using the hex key, loosen and remove the two socket head cap screws holding the cannister assembly against the mounting plate and remove the assembly from the GAE cabinet.

4-4. Install a new VCR gasket on the "old" reservoir assembly.

4-5. Remove the plastic protective cap from the "old" VCR plug and screw the plug into the female VCR nut on the top of the "old" cannister assembly. Snug it finger-tight, and then, using the 3/4" and 5/8" open-end wrenches, tighten it exactly 1/8 turn.

4-6. Tag the "old" cannister assembly to properly identify its contents. Include the serial number of the FIB system from which it was removed, and the date. Put it temporarily in a secure place for disposition in accordance with local procedures.

4-7. At V19 in the GAE cabinet, clean the male end of the VCR fitting with a clean dry wiper.

Part 5. Inspect and Install New Cylinder

5-1. On the "new" cannister assembly, make sure that the manual valve is in the *OFF* position.

WARNING

If you remove the VCR® plug from the cannister assembly while the manual valve is open, you will be exposed to Bromine vapor. Do not proceed until you make sure that the valve is closed.

5-2. Perform this step under a vented hood or in the vented GAE cabinet as follows: Using the 3/4" and 5/8" open-end wrenches, loosen and remove the VCR plug from the female nut at the top of the "new" cannister assembly. Place the plastic protective cap on the VCR plug, and store the plug in the bottom of the GAE cabinet.

5-3. Place a new VCR gasket on the "new" Br_2 cannister assembly.

5-4. Using the two socket head cap screws and the 5/32" hex key, mount the "new" cannister assembly. Do *not* tighten the cap screws yet.

5-5. Make up the VCR coupling by hand, adjusting the position of the cannister assembly as necessary. Snug the coupling finger-tight.

5-6. Using the 3/4" open-end wrench, tighten the female VCR nut exactly 1/8 turn.

5-7. Lightly tighten the socket head cap screws. *Do not open* the manual valve on the cannister assembly yet.

Part 6. Pump Down the Gas LIne

6-1. Pump down the gas line between the manual 1/4 turn valve on the cannister and valve V19 and leak-check the VCR coupling as follows:

a. Switch on the roughing pump, wait at least 30 seconds until TC1 reads ≤ 0.01 torr, then open valves V13, V15, and V16.

b. Open V17 as follows: go to the electronics module and, at the control panel for the MKS 244 pressure/flow controller for V17[2]; locate the valve mode selector switch on the right-hand end of the controller, and rotate the switch counterclockwise from the EXT position to the manual control position; then lift the adjacent toggle switch to the OPEN position (see 4).

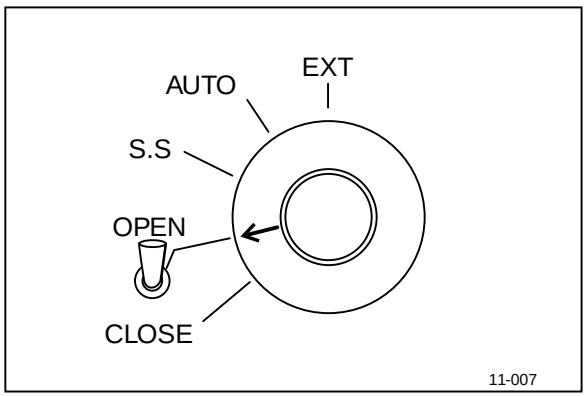


Figure 4. Valve Mode Switch (MKS 244 Pressure/Flow Controller).

c. When BT1 reads base pressure, close V15 and V16. Be sure to leave V19 open.

d. Watch BT1 for a rise in pressure, which indicates a leak. If this happens, close V19, and disconnect the VCR coupling, clean it, and clean or replace the gasket. When you have a leak-free connection, proceed to the next step. *Do not proceed until you have a leak-free connection*.

e. Open the manual *Process Gas Shutoff* valve on the outside of the GAE cabinet.

f. Open V15 and V16 for final pumpdown to base pressure.

6-2. With valves V12, V19, V15, and V16 closed, reactivate valve V17 as follows:

a. In the Gas Control Popup, click on the valve V17 icon to obtain the setpoint dialog box, and make sure that the *LeakValve* togglebutton reads *OFF*.

b. At the control panel for the MKS 244 pressure/flow controller, locate the valve mode selector switch on the right-hand end of the controller (see 4), rotate the switch clockwise to the EXT position, and move the toggle switch to its middle position.

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[2] If there is more than one MKS controller, the controller for V17 may be identified by a strip of yellow cable-marker tape.

Part 7. Reinstitute the Br_2

7-1. Open the manual valve on the Br_2 cannister assembly by turning the unlabeled manual valve 1/4 turn counterclockwise.

7-2. The Br_2 is shipped in 1 atmosphere (760 torr) of N_2 , which must be removed before GAE operations can be performed. Remove the N_2 as follows:

a. Check that the rough pump is on and that TC1≤0.01 torr.

b. Open V19; then close V19.

c. Open V16. (V17 and V15 are closed.)

d. Pump until TC1≤0.1 torr; then close V16.

e. Repeat steps b-d *five* times.

f. Open V19; open V16 for 5 seconds; close V19.

g. Pump until TC1≤0.01 torr; then close V16.

h. Open V19.

7-3. In the setpoint dialog box for V17, type in a setpoint of *1.00* and then click on the *Leak-Valve* toggle button so that it reads ON.

7-4. Open valve V12 to begin admitting gas to the workchamber. Observe the BT1 readback; it should continually register 1 torr, indicating that the gas flow is being properly regulated.

7-5. Close valves V12, V19, and V17.

7-6. Pump Br_2 from the common delivery lines:

a. Switch on the roughing pump and wait 30 seconds until TC1 reads ≤0.01 torr.

b. Open valves V15 and V16.

c. Wait until BT1 registers base pressure.

d. Close V15 and V16.

e. Switch off the roughing pump.

7-7. If Cl_2 and XeF_2 are installed, open the manual valve between V14 and the Cl_2 pressure regulator and the manual valve between V13 and the XeF_2 cannister.

7-8. Restore GAE cabinet ventilation to the normal flow rate by adjusting the gate valve.[3]

7-9. Remove the bypass for the shut-off safety interlock switch on the GAE cabinet door.

7-10. Close the GAE cabinet.[4]

---

[3] If you jumpered the high/low flow sensor, be sure to remove the jumper after the correct flow is restored.

[4] Whether or not the GAE cabinet should be locked, and who shall have custody of keys, may be governed by site safety policy.

Micrion

Service Procedure No.: **11-04**
Service Procedure Title: **Carbon Cylinder Replacement**
Applicable Systems: **8000**
Frequency of Service: **As Needed**

Do not undertake the procedure described herein without prior training and authorization by Micrion Corporation. Do not use this document as a substitute for that training. Normally, only Micrion service personnel perform this procedure.

This document comprises three parts: (1) preparations, (2) a general outline of the procedure, (3) the procedure itself, and (4) the Material Safety Data Sheet for styrene.

Notice

Per paragraph 11.1 of *Safety Guidelines for Semiconductor Manufacturing Equipment* (S2-93), this procedure is a *Type 2* task. Specifically: "Equipment is energized. Live circuits are covered or insulated. Work is performed at a remote location to preclude accidental shock."

Tools and Materials

- the "new" carbon cylinder assembly (part no. 100-010040) charged with 30 ml of styrene at the Micrion factory, pumped down to the 5 to 7 torr range (the vapor pressure of styrene at room temperature) with the manual valve on the assembly closed.
- the VCR[1] plug for the "old" cylinder assembly (normally in bottom of cabinet)
- two new VCR gaskets (part no. 355-000027)
- rubber gloves and safety glasses
- dry wipes and swabs for cleaning
- a disposal bag for contaminated waste (used wipes, gaskets, etc.)
- a 3/4" open end wrench
- a 5/8" open end wrench
- a hex key set
- heat sink compound (part no. 700-000026)

[1] *VCR* is a registered trade mark of the Cajun Company, Macedonia, Ohio.

Part 1. Preparations

1-1. Review the Material Safety Data Sheet for styrene in Section 2.

1-2. Secure the help of another person—two people should be present during this procedure.

1-3. Review the procedures provided by the site's Chemical Safety Officer governing tasks of this nature. If no such procedures have been provided, alert the site's Chemical Safety Officer that you will be performing this task. If the site does not have a designated Chemical Safety Officer, alert site management personnel (as well as any personnel present in the general area surrounding the FIB system) that you will be performing this task.

1-4. Identify exits, safety shower, eye wash station, etc. If the site does not provide an eye wash station, a portable eye wash station should be procured.

1-5. Assemble the tools and materials.

1-6. Review the layout of the cylinder bay in the carbon cabinet (see figure 1).

1-7. At the FIB system workstation, with the application software program running, pull down the Gas menu and click on *Carbon Control* to obtain the Gas Control Popup dialog box for the carbon delivery system (see figure 1).

Part 2. Outline

This part describes the overall strategy for changing the reservoir.

2-1. Disable the reservoir cooler by disconnecting the electrical cable to the cooler.

2-2. Close the manual shutoff valve on the "old" carbon cylinder assembly, and rough-pump the gas lines leading back to it.

2-3. Remove the "old" carbon cylinder, install the VCR plug, and tag the cylinder.

2-4. Install the "new" carbon cylinder assembly.

2-5. Enable the reservoir cooler.

2-6. Pump the gas lines leading back to the "new" cylinder assembly and leak-check the installation.

2-7. Wait for the reservoir to cool.

2-8. Reinstitute gas flow to the FIB system workchamber.

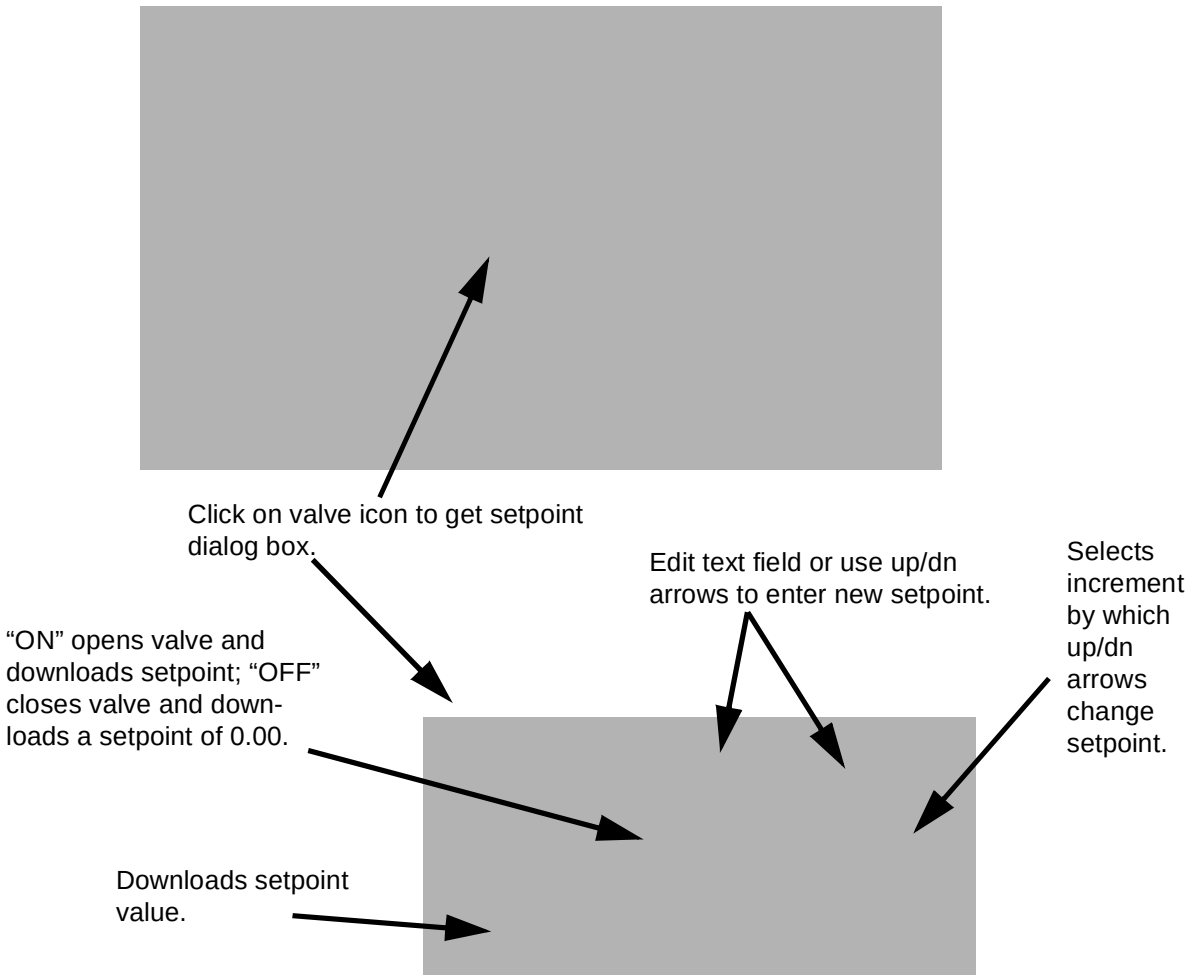
Click on valve icon to get setpoint dialog box.
Edit text field or use up/dn arrows to enter new setpoint.
Selects increment by which up/dn arrows change setpoint.
"ON" opens valve and downloads setpoint; "OFF" closes valve and down-loads a setpoint of 0.00.
Downloads setpoint value.

Figure 1. Gas Control Popup Dialog Boxes.

CAUTION

Both the "old" and "new" cylinders contain styrene, which is flammable, carcinogenic, may irritate eyes and nose, and may otherwise be harmful if inhaled, ingested, or absorbed through the skin.To minimize the risks of exposure and fire, you must follow this procedure exactly.

Part 3. Procedure

3-1. At the top left-hand top corner of the outside rear of the cylinder bay on the carbon box, loosen the screws that secure the electrical connector for the reservoir cooler and disconnect it.

3-2. Make sure that the carbon cabinet exhaust system is operating correctly. Note that the pushbutton switch near the door handle on the cabinet's main bay door should be illuminated lime-green (dc power to control the pneumatic valves must be enabled) at this time.

3-3. Remove the six screws that secure the access plate to the cylinder bay on the left-hand side of the carbon cabinet, and remove the access plate.

3-4. Close the manual valve on the "old" cylinder assembly by turning it ¼ turn clockwise.

3-5. In the Gas Control Popup, close valves V31 through V36. To close valve V35, click on the valve icon to obtain the setpoint dialog box (see figure 2), then click on the *LeakValve* toggle button so that it reads *OFF.*

3-6. Click on the RP1 icon to switch the roughing pump on. Wait at least 30 seconds.

3-7. Open valves V31, V32, and V33, and wait for BT3 to indicate base pressure (≅ 0.00). This may take 15 minutes or longer.

3-8. When BT3 reads base pressure, close valves V32, and V33

3-9. At the control panel for the MKS 244 pressure/flow controller, which is mounted in the electronics module, open V35 fully by rotating the valve mode selector switch on the right-hand end of the controller counterclockwise from the *EXT* position to the manual control position and lifting the adjacent toggle switch to the *OPEN* position. See figure 2.

Figure 2. Valve Mode Switch (MKS 244 Pressure/Flow Controller).

3-10. Record the BT3 reading as a function of time (to characterize the rate of outgassing).

3-11. Close V31; close V35 by moving the toggle switch on the MKS pressure/flow controller to the *CLOSE* position.

3-12. On the carbon cabinet door, press the pushbutton switch to deactivate the pneumatic valves (the lime-green indicator light on the switch should go dark).

3-13. Put on the rubber gloves and safety glasses and remove the "old" cylinder assembly from the cylinder bay as follows:

NOTICE

To avoid applying torque that may damage fittings and/or disturb other gas line connections when making or breaking the coupling, always use two wrenches—one to immobilize the upper part of the coupling, and one to tighten or loosen the nut on the lower side of the coupling.

a. Loosen the coupling above the manual valve (see figure 1) by holding the upper part of the coupling immobile with the 5/8" open end wrench and turning the nut with the 3/4" open end wrench. It may be necessary to open the access door on the carbon box's main bay and work through the opening between the two bays. Finish disconnecting the coupling by hand.

b. Loosen and remove the two bottle clamp mounting screws nearest the outer edges of the bottle clamp (see figure 1). Remove the clamp and place it aside, being careful not to damage the wiring to the temperature sensor secured to the clamp.

c. Loosen and remove the two cylinder assembly mounting screws (see figure 1), and remove the assembly from the cabinet.

d. Install a new VCR gasket on the "old" reservoir assembly.

e. Remove the plastic protective cap from the "old" VCR plug and screw the plug into the female VCR nut on the top of the "old" cylinder assembly. Snug it finger-tight, and then, using the two open end wrenches, tighten it exactly 1/8 turn.

f. Tag the "old" cylinder assembly so as to properly identify its contents. Include the serial number of the FIB system and the date of removal.

3-14. In the carbon cabinet, clean the male end of the VCR fitting with a clean dry wiper.

3-15. Apply silicone heat sink compound to the insides of the bottle bracket and clamp.

3-16. On the "new" cylinder assembly, make sure that the manual valve is in the *OFF* position.

CAUTION

If you remove the VCR plug from the cannister assembly while the valve is open, you may be exposed to styrene vapor and to styrene liquid. Do not proceed unless the manual valve is and is now closed. If the manual valve was inadvertently do not proceed. Contact Micrion Corporation for further instructions.

3-17. If possible, perform this step under a vented hood: Using the two open end wrenches, loosen and remove the VCR plug from the female nut at the top of the "new" cylinder assembly. (Place the plastic protective cap on the VCR plug, and store the plug in the bottom of the carbon cabinet.)

3-18. Inspect the VCR fitting on the top of the "new" cylinder assembly. Install a new gasket.

3-19. Install the "new" cylinder as follows:

g. Secure the assembly loosely to the rear wall of the cabinet with the two cylinder assembly mounting screws (see figure 1). Do not tighten these screws yet.

h. Make up the VCR coupling by hand, adjusting the position of the cylinder assembly as necessary. Snug the coupling finger-tight.

i. Holding the upper part of the coupling immobile with the 5/8" open end wrench, tighten the VCR nut exactly 1/8 turn with the 3/4" open end wrench.

j. Replace the bottle clamp and secure it with the two bottle clamp mounting screws.

k. Tighten the cylinder assembly mounting screws to secure the assembly to the cabinet wall. Do not open the manual valve on the cylinder assembly yet.

3-20. Reconnect and secure the cylinder cooler electrical cable at the top rear corner of the cylinder bay. This initiates cooling of the "new" cylinder.

3-21. Set the cylinder cooler to maintain the cylinder temperature at 5° below ambient temperature as follows:

a. Start the *vacchat* program (if *ui* is running, you can select it from the menu that appears when you press the right-hand mouse button while the screen pointer is in the background screen).

b. With the screen pointer in the *vacchat* window, enter the command `sc1sp` to query the controller for the *setpoint* (the desired temperature difference between cylinder and ambient). The response should be 5 degrees C. If it is not, adjust potentiometer R8 near the top of the cooler control board (150-1501 or 150-1581[2]) in the vacuum control unit as necessary so that you obtain the correct response when you query the controller with *vacchat*.

c. Note the time before proceeding (it will take at least 30 minutes for the cooler to cool the cylinder). Do not terminate the *vacchat* program yet.

3-22. On the carbon cabinet's main bay door, press the pushbutton switch so as to activate the pneumatic valves (the lime-green indicator light on the switch should light).

3-23. Pump down the gas line between the manual valve on the cylinder and valve V31 and leak-check the VCR coupling above the manual valve as follows:

a. Switch on the roughing pump and wait at least 30 seconds.

b. Open valves V31, V32, and V33.

c. When BT3 indicates base pressure, close V32 and V33 and switch off the roughing

[2] The 1501 and 1581 controller boards are identical.

pump. Be sure to leave V31 open.

d. Open V35 by moving the toggle switch on the MKS pressure/flow controller to the *OPEN* position.

e. Monitor BT3 and compare the pressure rise with the characterization that you established earlier in step number 3-8. Watch for a rapid rise in pressure, which would indicate a leak. If a leak is indicated, close valve V31, and then disconnect the VCR coupling, clean it, and replace the gasket. Do not proceed until you have a leak-free connection.

3-24. Wait at least 30 minutes from the time that you noted earlier (step 3-21, substep c) for the cylinder to cool. Use the *vacchat* program to query the controller: the `sc1at` command obtains ambient temperature; `sc1ct` obtains cylinder ("control") temperature. You must wait until the cylinder temperature is 5° below the ambient temperature. You can then terminate the *vacchat* program.

3-25. Close V31 (if it is not already closed), open the manual valve on the cylinder assembly briefly, and then close it again.

3-26. Open V31 and note the BT3 readback. Ideally, the pressure will be stable in the range of 5 to 7 torr. In any case:

f. Switch on the roughing pump, wait 30 seconds, then open V32 and V33.

g. *Slowly* open the manual valve on the cylinder assembly (¼ turn), and rough pump the cylinder for 5 to 30 seconds.

h. Close V32 and V33 and note the rate of rise indicated by BT3. If the pressure remains stable in the 5 - 7 torr range, proceed to step number 3-27. If the pressure rises rapidly, the indication is that the cylinder assembly has leaked, in which case, contact Micrion Product Support for advice; you may have to procure another "new" cylinder assembly and begin again.

3-27. At this point, the manual valve should be fully open, V35 should be fully open (manually, through the pressure/flow controller), V31 should be open, and V32, V33, V34 and V36 should be closed. BT3 should be indicating pressure in the 5 to 7 torr range. The roughing pump is on.

3-28. Close V31.

3-29. Reinstall the carbon cabinet access panel on the cylinder bay and close the main bay door.[3]

3-30. Open V32 and V33 and rough pump the delivery lines until BT3 reads ≤ 0.01 torr, then close V32 and V33 and switch off the roughing pump.

3-31. Reactivate (and close) valve V35 as follows:

a. Click on the valve V35 icon to obtain the setpoint dialog box. If the *LeakValve* toggle-button reads *ON*, click on it so that it reads *OFF.*

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[3] Whether or not the cabinet should be locked, and who shall have custody of keys, may be governed by site safety policy.

b. At the control panel for the MKS 244 pressure/flow controller, rotate the valve mode selector switch on the right-hand end of the controller (see figure 2) clockwise to the EXT position, and move the toggle switch to its middle position.

3-32. Open valve V31.

3-33. In the setpoint dialog box for V35, enter a setpoint of *1.40*, and then click on the *Leak-Valve* toggle button so that it reads *ON*. Wait until BT3 stabilizes before proceeding.

3-34. Open V36 to admit styrene vapor to the workchamber. The HCIG readback should indicate a sharp initial rise in workchamber pressure, but it should then stabilize at about 8 x 10^{-6} torr.

3-35. To place the carbon delivery system in an idle state:

a. Close valves V31, V35, and V36

b. Switch on the roughing pump, wait at least 30 seconds, and then open valves V32 and V33.

c. When BT3 reads base pressure, close V32 and V33 and switch off the roughing pump

d. Press the pushbutton switch on the carbon cabinet door to deactivate the pneumatic valves (the green indicator light on the switch should go dark).

Section 12: System Controller

- 12-01 SysCon Overview
- 12-02 SysCon Power Supplies, Circuit Breakers, and Switches
- 12-03 Using a MultiBus Extender Board
- 12-04 Bit3 Board: 125B
- 12-05A Knob Panel Interface Board: 841
- 12-05B Knob Panel Interface Board: 1810
- 12-06 Stage/Aperture Drive Boards: 891/892/893
- 12-07 Analog Drive Board: 1082
- 12-08 High Voltage Interface Board: 1102 *(Not included)*
- 12-09 Raster Generator Board: 1110
- 12-10 Signal Acquisition Board: 1381
- 12-11 Flood Gun Interface Board: 1090
- 12-12 Flood Gun Supply Board: 1130

Micrion

Service Procedure No.: **12-01**
Service Procedure Title: **SysCon Overview**
Applicable Systems: **All**
Frequency of Service: **As needed**

Introduction

The Raster Generator, the Analog Drive, and the Signal Acquisition boards are the heart of the SysCon imaging system. The combination of the Raster Generator and Analog Drive boards generates the scan capability, while the Signal Acquisition board converts analog signals from the MCP into digital form. The digital signals are passed to the Univision board, which is in the computer module.

The remaining boards include the Knob Panel Interface, the Stage/Aperture Drive boards, the Flood Gun Interface and Flood Gun Supply boards, the Frame Processor board, and the Bit3 Interface board.

The SysCon power supplies, SysCon circuit breakers, and SysCon switches are described in Service Procedure 12-02. If you need a MultiBus Extender Board, see Service Procedure 12-03.

Tools and Materials Required

Oscilloscope or Voltmeter

Trademarks

- Univision is a registered trademark of Univision Technologies, Inc.

Returning Faulty Boards to Micrion

To return faulty boards or other defective hardware (except for consumables) to Micrion, obtain a Return Material Authorization (RMA) by calling or faxing:

Micrion Customer Support Logistics
Voice: 508-531-6464 or Fax: 508-531-5481

An RMA will be issued according to your current system status and contract. If applicable, you may request a Repair Purchase Order at this time.

ELECTROSTATIC DISCHARGE

Printed circuit boards are sensitive to electrostatic discharge. Handle boards as follows: 1) Touch your hand to the chassis's metal frame to discharge static, or wear a static grounding strap; 2) Hold the board by the ejector tabs; 3) If you must lay the board down, lay it component side down.

Table 1 is an introduction to the SysCon boards. Figure 1 shows the factory configuration of the boards in the SysCon module.

Table 1: SysCon Boards: Numbers, Names, and Functions

No.	Board Name	Board Function
125B	**Bit3**	Computer-to-SysCon interface
841	**Knob Panel Interface**	Knob panel interface; keyboard separate
891	**Stage Motor Drives**	Motor drivers; X, Y, including 6 servo and 2 stepper channels
892	**Aperture Motor Drives**	Motor drivers; aperture positioning, including 6 servo and 2 stepper channels
1082	**Analog Drive**	Digital scan data downloaded from the Raster Gen (1110) board is converted to an analog signal. Generates x and y scans plus stigmation, lens shift, and rotation.
1110	**Raster Generation**	Provides digital scan (deflection) data to Analog Drive board; synchronizes imaging parameters to the Sig Acq.
1381	**Signal Acquisition**	Imaging signal acquisition; 8-bit ADC, column sense signals; interface to Univision imaging board.
1850	**Frame Processor**	Randomly averages out the digital video noise.
1090	**Flood Gun Interface**	Computer-to-1130 interface allowing control of all flood gun supply voltages; readback of supply voltages.
1130	**Flood Gun Supply**	Flood gun power and detector screen voltage: FIL1, CathB, Grid, Focus, Deflection, and Screen

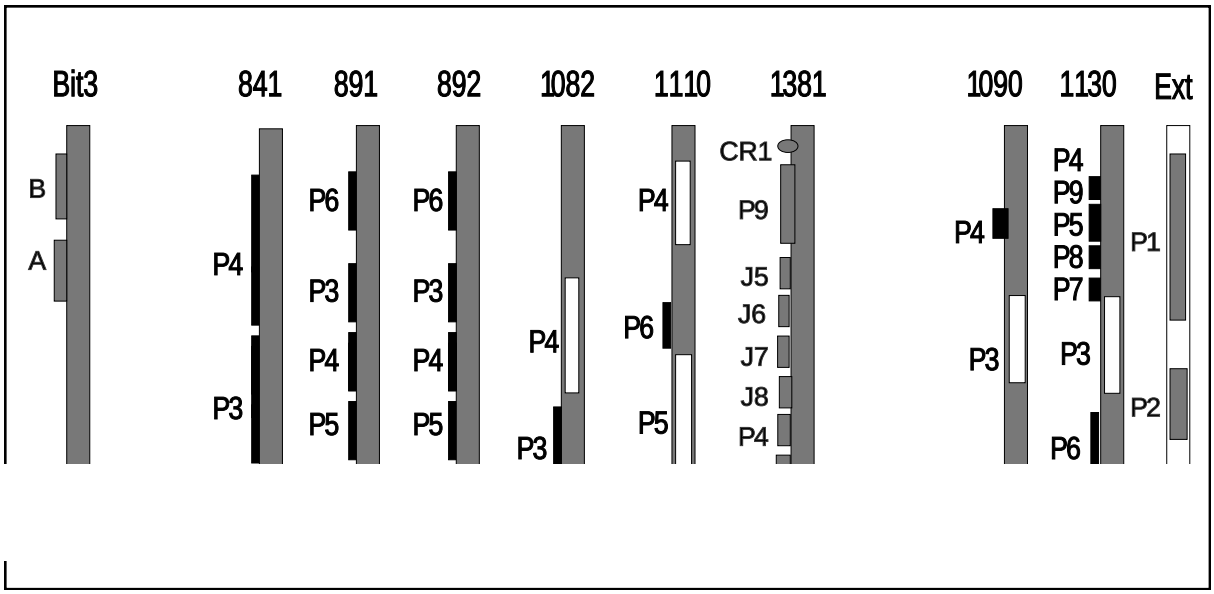


Figure 1. SysCon Boards: Factory Configuration

Figure 2 is a block diagram of the SysCon boards and their relationship to the whole system.

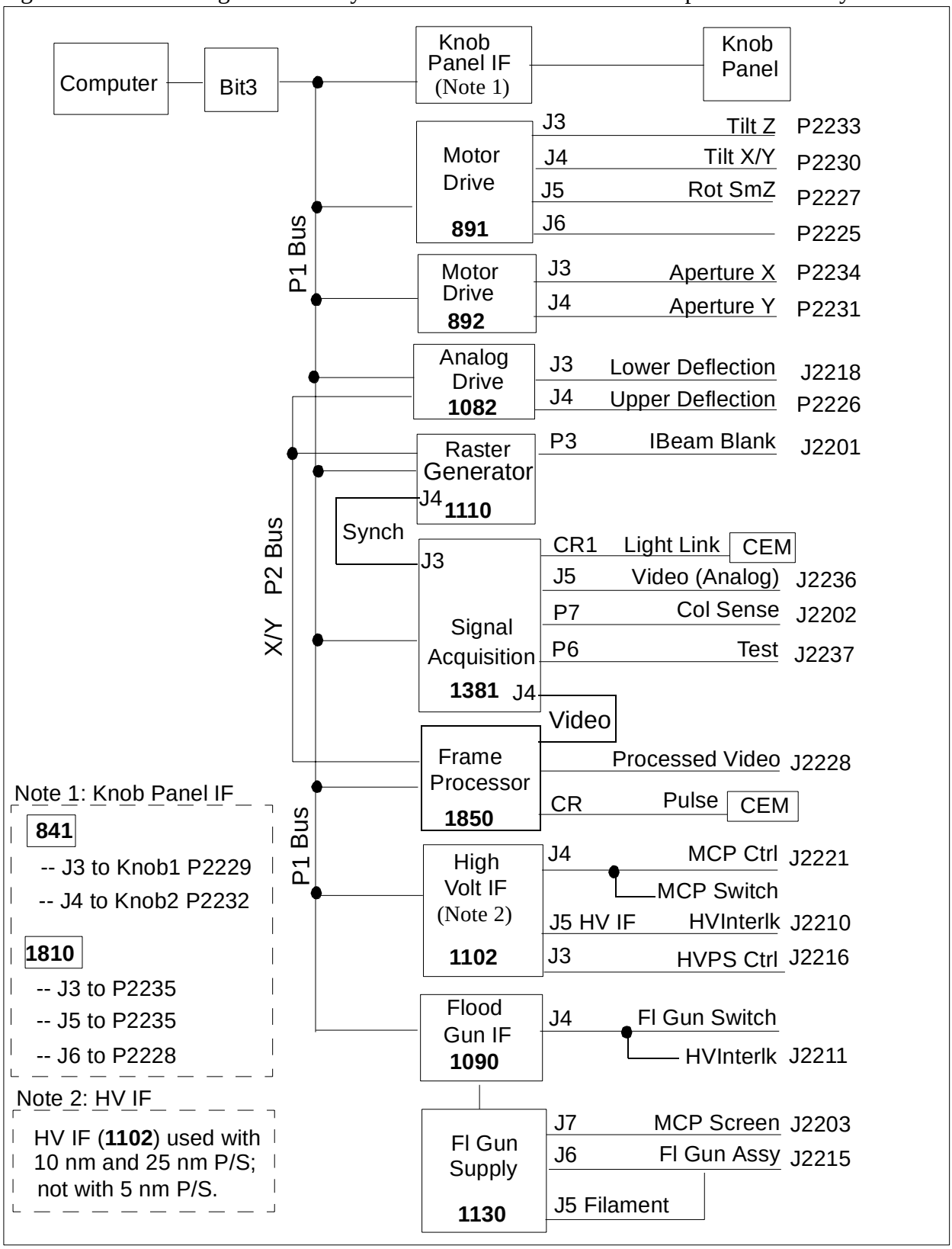


Figure 2. SysCon Block Diagram

Table 2: SysCon Rear Panel Connectors (From top left of the rear chassis to lower right)

Connector	To/From
IBLANK J2201	I-Blanking amp (150-434) /1110
COL SEN J2202	Col Sense amp (150-813) /1381
SCREEN J2203	MCP screen /1130
HV INTLK P2210	High voltage power supply
VACHV INTLK J2211	Pwr dist unit, ion pump p/s, fluids reg, back door, column conns
HV WARN P2212	
FAN1 J2213	
FAN2 J2214	
FGUN CONT J2215	Flood Gun/1130
HVPS CONT J2216	Bertan -1 & -2, Focus2 /1102
DEF PWR J2217	Column electronics / Def Pwr switch on chassis front, and rear chassis power supplies
PHOTO J2218	
J2220	
MCP CONT J2221	MCP power supply box /1102
DEFLECTION P2226	Column elect (recvr bds) /1082
ROT/SM Z P2227	Stage/891
P2225	
KNOB1 P2229	Knob panel/841
TILT X/Y P2230	Servo/891
SIGNAL ACQ P2228	Computer (Univision Bd)/ Video
KNOB2 2232	Knob panel/841
APER P2231	Aperture Y/89xJ4
SOURCE P2234	Aperture X/89xJ3
TILT /Z P2233	Servo/891

Typical SysCon System and Board Problems

Table 3 lists the typical problems that you might encounter that are due to a faulty SysCon board. See the individual corrective procedures 12-04 through 12-11.

Table 3: Typical SysCon System and Board Problems

Symptom	Board	Problem	Proc.
System will not reset; Invalid readbacks	**Bit3**	Board seated incorrectly Cables not locked in place	12-04
Erratic operation of the knob panel	**1810**	Jumpers Fuses	12-05
Motor(s) dead	**891**	Jumpers Fuses Drive outputs	12-06
Motor(s) dead	**892**	Jumpers Fuses Drive outputs	12-06
No scan or noisy image No stigmation wobble No rotation Super-imposed image	**1082**	DACs	12-07
No scan or noisy image	**1110**	Scan sigs missing from 1082 (Ana Drive) No image sync to 1381 (Sig Acq)	12-09
No scan or noisy image; Multiple images; Image breakup during scan; Bbaper/IonFara-day/ElecFaraday	**1381**	Video electronics gain Column sense amp chain	12-10
Flood gun system partially working or not at all	**1090**	DAC to 1130 (Fl Gun Supply) Readbacks from 1130	12-11
Flood gun system partially working or not at all	**1130**	Outputs HV missing or loaded down Resistors burned	12-12

Micrion

Service Procedure No.: **12-02**
Service Procedure Title: **SysCon Power Supplies, Circuit Breakers, & Switches**
Applicable Systems: **All**
Frequency of Service: **As needed**

Introduction

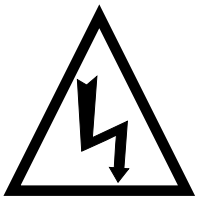
This procedure describes the power supplies, fuses, and switches for the System Controller subsystem, and contains the following subsections:

- Checking Circuit Breakers
- Checking Power Supplies on the Terminal Blocks
- Using Front Chassis Switches and Coax Connectors

Tools and Materials Required

Voltmeter

WARNING



Dangerously high voltage is present in the process module and the System Controller module while the FIB system is powered up. All high voltage wiring is heavily insulated and connections are interlocked. However, any such safeguards can fail. Therefore, do not touch any of the wiring in or on the process module or the System Control module while the FIB system is powered-up.

NOTICE

Per paragraph 11.1 of *Safety Guidelines for Semiconductor Manufacturing Equipment* (S2-93), this procedure is a Type 4 task. Specifically:
"Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are greater than 30 volts RMS, 42.2 volts peak, 240 volt-amps, and 20 Joules."

Part 1. Checking Circuit Breakers to Power Supplies

The six circuit breakers in the SysCon circuit are listed in Table 1. They are located at the rear of the electronics module, as shown in Figure 1.

Table 1: SysCon Circuit Breakers

Fuse	Circuit
+/- 150V	Deflection Power
24V	Fans
5V	Logic
+/- FLGN	Flood Gun (NOT USED)
RSYNC	Raster 120 Vac
+/- 15V	Analog electronics

If a circuit breaker pops out, check for a short circuit; press the circuit breaker back in to reset.

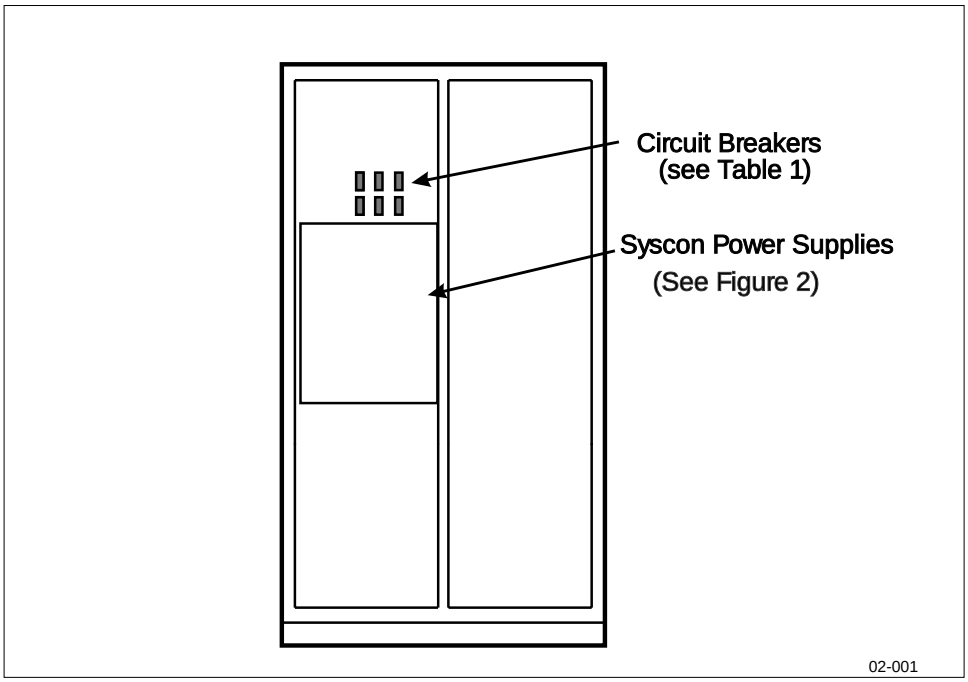


Figure 1. SysCon Section of the Electronics Module (Rear)

Part 2. Checking Voltages on the Power Supply Terminal Blocks

On the floor of Power Supply module are the terminal blocks, shown in Figure 2. These terminal blocks can be checked for the voltages listed in Table 2. With a voltmeter, test for specific voltages at the taps listed in Table 2.

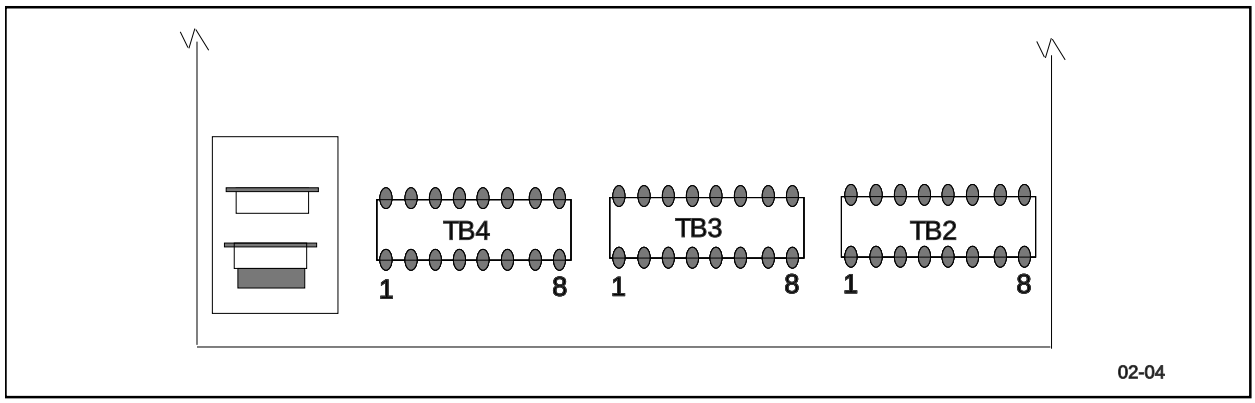


Figure 2. Terminal Blocks on Floor of SysCon Power Supply Module (Top View)

Table 2: Terminal Block Voltage Taps

Voltage	Terminal Block	Test Taps	Wire Colors
+5 (+/- 3%) +15 (+/- 3%) -15 (+/- 3%) dc	TB4	1-2 5-6 7-8	Red-Black Orange-Black Black-Yellow
+150 (+/- 3%) -150 (+/- 3%)	TB3	1-2 3-4	Blue-Black Violet-Black
+24 (+/- 3%) dc	TB2	1-2	Blue-Black

Also check the chassis ground lugs for secure connection.

Part 3. Front Chassis Switches and Coax Connectors

The SysCon front chassis switches are shown in schematic in Figure 3 and in physical location in Figure 4; they are described, along with the coax connectors, in Table 3.

Table 3: SysCon Front Chassis Switches and Connectors

Switches	Function
Main Power CB1	Power to all SysCon boards, and to: the Deflection Power, MCP Power, and Flood Gun switches
Deflection Power S1	+/-150V and +/-15V to column electronics
MicroChannel Plate (MCP) Power S2	Power to MCP power supply box preamp
Flood Gun[a] S3	Enable Flood Gun. When this switch is off, the LED (DS1) on the Flood Gun Interface board is off, disabling P6 on the Flood Gun Supply board. Voltages are still alive on the Flood Gun Supply board.
Coax Connectors	**Function**
Video J2236	Video signal from Signal Acquisition board (assuming JP1is set on Signal Acquisition board)
Test J2237	Video input to Signal Acquisition board (for factory test)

a. Turning off S3 does not turn off high voltages on the flood gun board itself; however, turning off S3 does disable high voltages on the P6 output connector of the flood gun board.

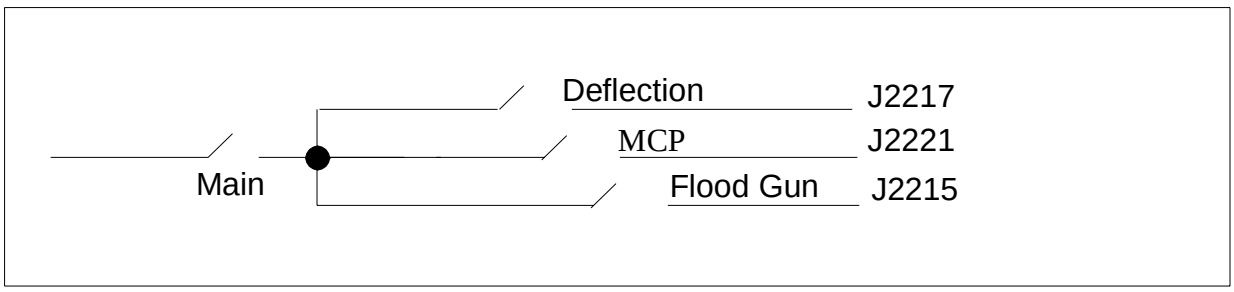


Figure 3. Schematic: SysCon Front Chassis Switches

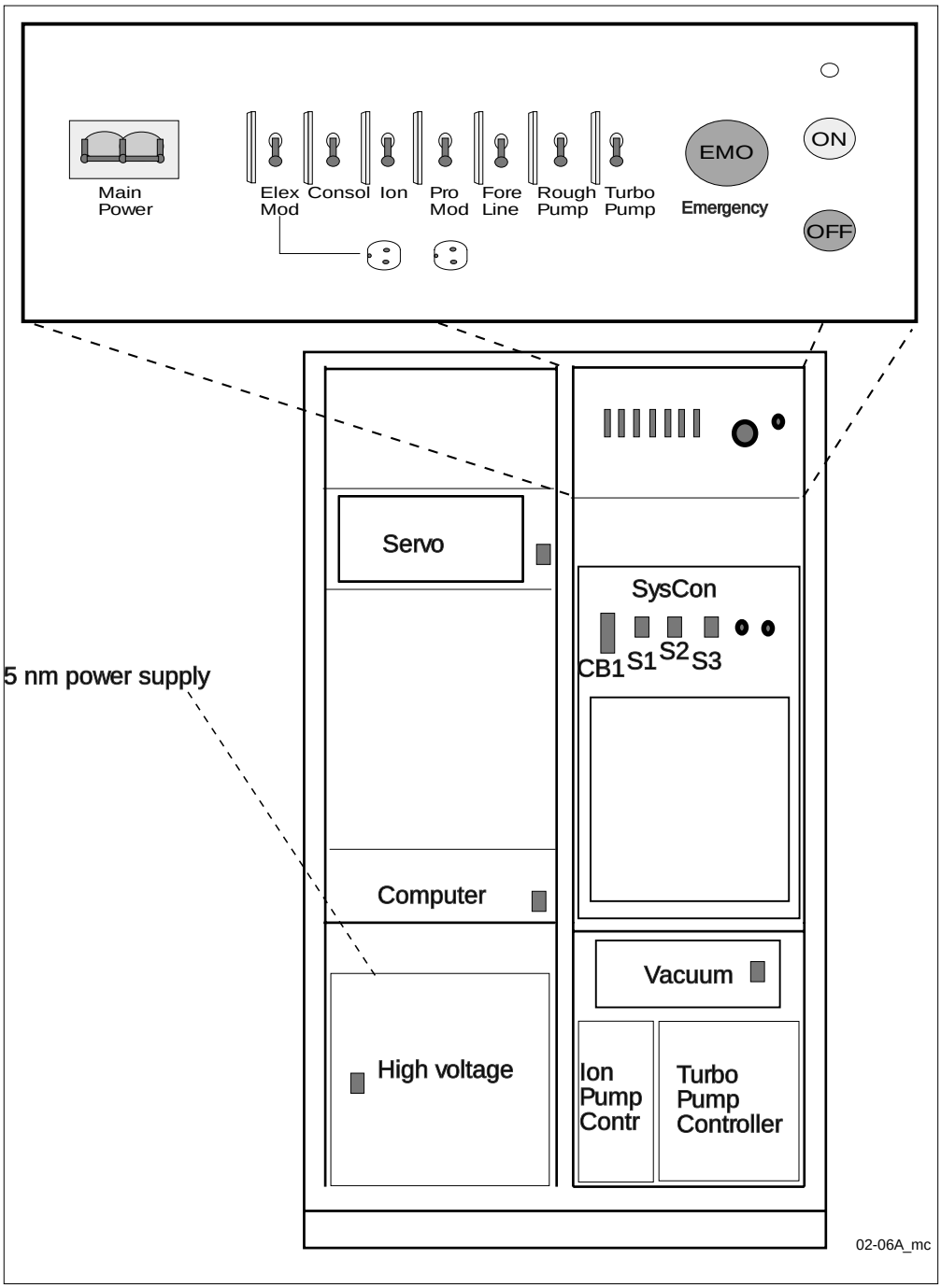


Figure 4. Electronics Module Switches and Modules

Part 4. To Power Down the SysCon

4-1. See Service Procedure 01-02. Switch off the following switches on the SysCon module described in Table 3: CB1, S1, S2, and S3.

Micron

Service Procedure No.: **12-03**
Service Procedure Title: **Adding an Extender Board**
Applicable Systems: **All**
Frequency of Service: **As needed**

Introduction

This procedure covers the installation of a Multibus extender board in the SysCon module.

Tools and Materials Required

Multibus Extender Board

NOTICE

Per paragraph 11.1 of *Safety Guidelines for Semiconductor Manufacturing Equipment* (S2-93), this procedure is a Type 5 task. Specifically:
"Equipment is energized. Measurements and adjustments require physical entry into the equipment."

Part 1. Extender Board Procedure

1-1. Follow the steps in Service Procedure 01-02 to power down.

1-2. On the printed circuit board you want to test, disconnect the connectors; remove the board.

1-3. Insert the Multibus extender board in the same slot.

1-4. Add the board to the extender board and reconnect the board connectors.

1-5. Restart the Syscon by turning on the main circuit breaker, then turn on S1, S2, and S3.

1-6. You have to re-zero the stage once the system has come back up.

Part 2. Be Alert for Sprung Pins

Check the extender board for sprung pin(s) shown in Fig.ure 1. Sprung pins must be re-soldered.

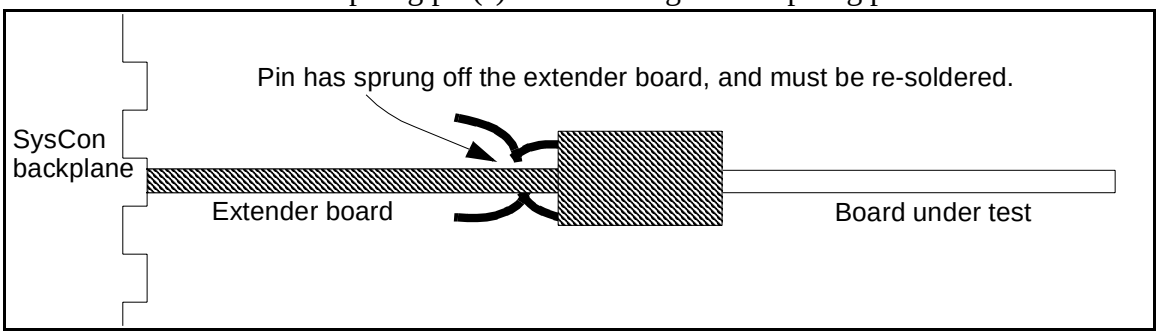


Figure 1. Top View: Extender Board with Sprung Pin

Micron

Service Procedure No.: **12-04**
Service Procedure Title: **Bit3 MicroChannel Multibus Adapter: 125B**
Applicable Systems: **All**
Frequency of Service: **As needed**

Introduction

The Bit3 board pair--one in the computer and one in the first slot of the SysCon module--adapts the computer's Microchannel bus to the Multibus of the SysCon. The computer board enables the computer to see the SysCon as a virtual memory-mapped I/O.

ELECTROSTATIC DISCHARGE

This board is sensitive to electrostatic discharge. Handle the board as follows: 1) Touch your hand to the metal frame of the chassis to discharge static, or wear a grounding strap; 2) Hold the board by the ejector tabs; 3) If you must lay the board down, lay it component side down.

Part 1. Checking the LEDs on the Bit3 Board

As shown in Figure 1, the two LEDs on the front of the board are active. The lower LED is on continuously after you initialize the computer. The upper LED flashes on during data transfer.

Part 2. Resetting the Bit3 Board

The Bit3 board should automatically reset when the system is powered up. If not, use the system command:

```
mbus_reset
```

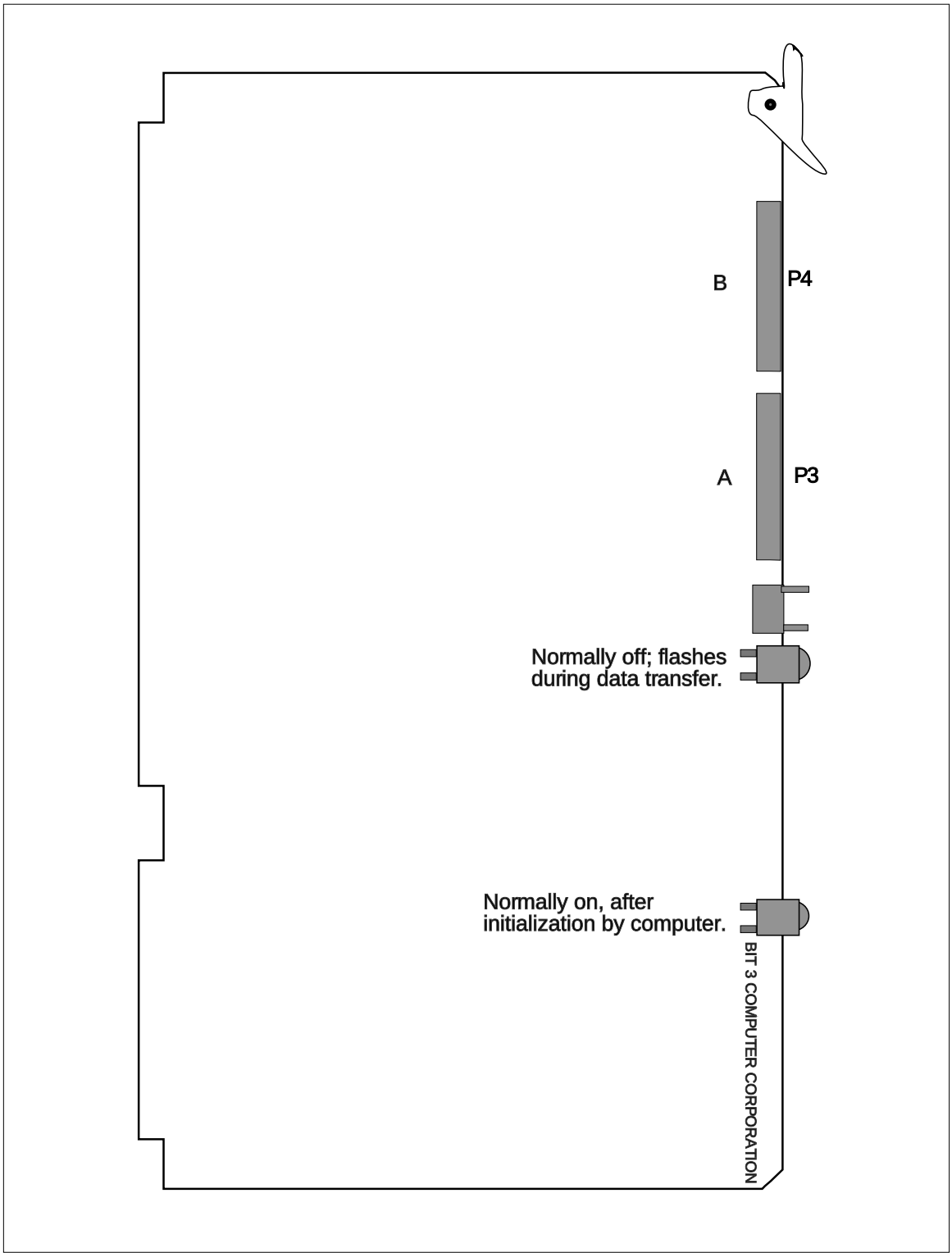


Figure 1. 125B: Bit3 MicroChannel Multibus Adapter

Micrion

Service Procedure No.: **12-05A**
Service Procedure Title: **Knob Panel Interface Board: 841**
Applicable Systems: **All**
Frequency of Service: **As needed**

Introduction

The knob panel connects directly to the knob panel interface board via P3 and P4. The interface board notifies the computer of knob, joystick, and switch events as they occur.

Tools and Materials Required

- Oscilloscope
- Ohmmeter

ELECTROSTATIC DISCHARGE

This board is sensitive to electrostatic discharge. Handle the board as follows: 1) Touch your hand to the metal frame of the chassis to discharge static, or wear a grounding strap; 2) Hold the board by the ejector tabs; 3) If you must lay the board down, lay it component side down.

NOTICE

Per paragraph 11.1 of *Safety Guidelines for Semiconductor Manufacturing Equipment* (S2-93), this procedure is a Type 5 task. Specifically: "Equipment is energized. Measurements and adjustments require physical entry into the equipment."

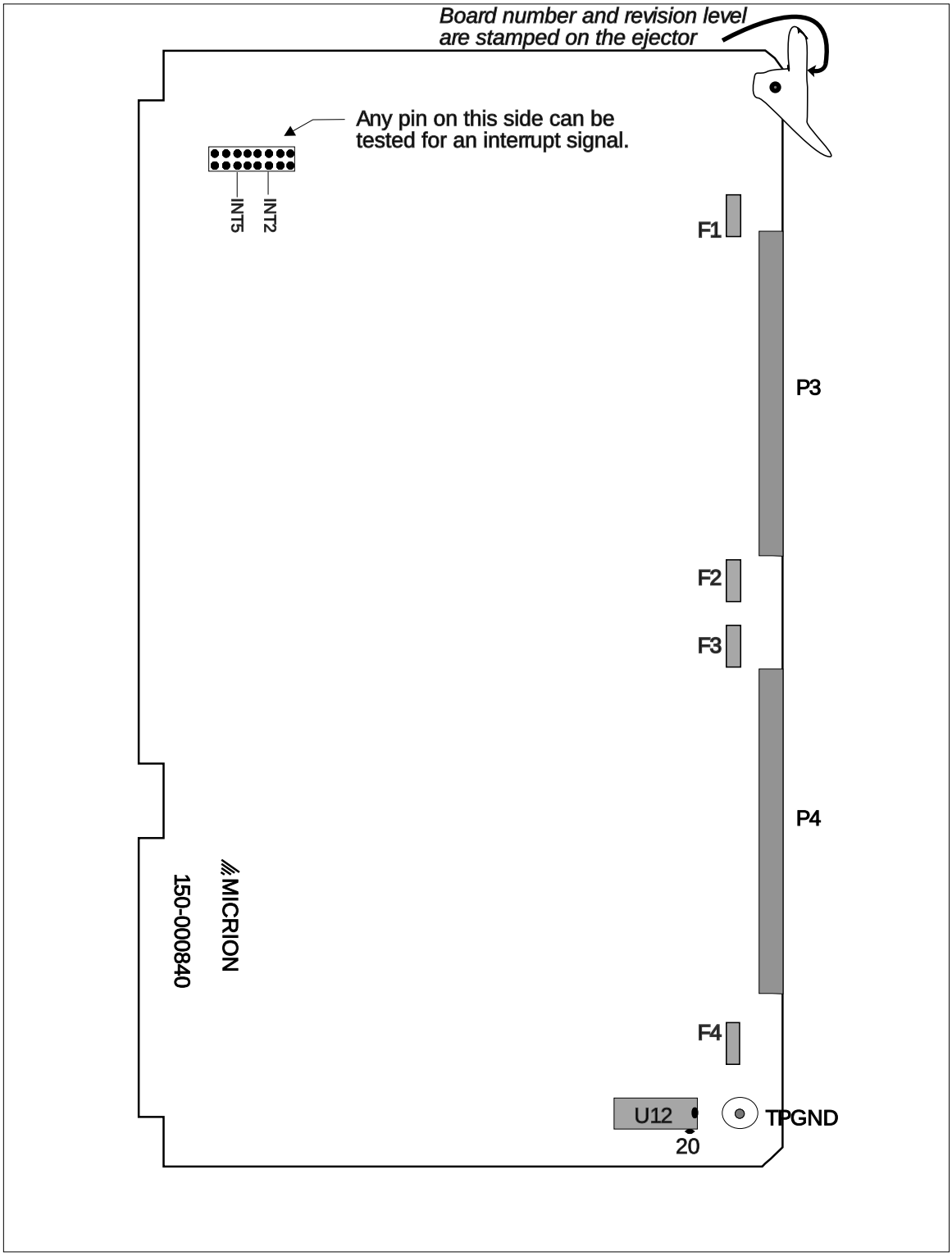


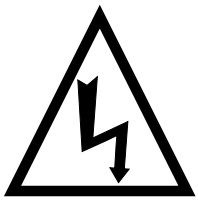
Figure 1. 841: Knob Panel Interface

Part 1. Power Down Before Disconnecting P3 or P4

Before removing the connectors at P3 or P4 of the Knob Panel board, follow the power down procedure in Service Procedure 01-02.

Note: P3 and P4 inputs must not be interchanged.

WARNING



Dangerously high voltages are present while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and auto procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

Part 2. Testing for Interrupt Generation and Clearance

2-1. With the SysCon module powered down, put the Knob Panel board on the extender board.

2-2. Unplug P3 and P4.

2-3. With an ohmmeter, test F1, F2, F3, and F4 for < 1 ohm.

2-4. Clip the oscilloscope probe on any input pin on the interrupt block shown in Fig. 1.

2-5. Power up the SysCon module.

2-6. In an xterm window, run the mbus_reset command:

```
mbus_reset
```

2-7. Start the Microsurgery application.

2-8. The signal from the interrupt block should be high until there is an interrupt. To generate an interrupt, turn any knob on the knob panel. The signal should go low. The computer should process the interrupt and clear it, sending it high after < 10 milliseconds. If the signal is always high, no interrupt is being generated from the knob panel. If the signal is always low, a continuous interrupt is asserted on the interrupt bus. This is a TTL-compatible signal.

Table 1 summarizes the test points.

Table 1: Knob Panel Interface Test Points

Point	Problem	Signal Characteristics If Correct
U12-pin 20	No power	5V +/- 100 mV noise
Interrupt Block	Interrupts unseen by computer	See step 2-8.
F1, F2, F3, F4 (1A; Micrion p/n 540-000018)	Switches/LEDs not working, but key-board is all right	<1 ohm**.**

Part 3. Interrupt Jumper

Check the interrupt jumper, which is set according to the type of computer in use.

Table 2: Jumpers

Intel 486	INT 2
IBM 370	INT 5

Micron

Service Procedure No.: **12-05B**
Service Procedure Title: **Knob Panel Interface: 1810**
Applicable Systems: **All**
Frequency of Service: **As needed**

Introduction

The knob panel connects directly to the knob panel interface board via P3 and P4. The interface board notifies the computer of knob, joystick, and switch events as they occur.

The 1810 controls the keyboard as well as the knob panel.

Tools and Materials Required

Oscilloscope

Ohmmeter

ELECTROSTATIC DISCHARGE

This board is sensitive to electrostatic discharge. Handle the board as follows: 1) Touch your hand to the metal frame of the chassis to discharge static, or wear a grounding strap; 2) Hold the board by the ejector tabs; 3) If you must lay the board down, lay it component side down.

NOTICE

Per paragraph 11.1 of *Safety Guidelines for Semiconductor Manufacturing Equipment* (S2-93), this procedure is a Type 5 task. Specifically: "Equipment is energized. Measurements and adjustments require physical entry into the equipment."

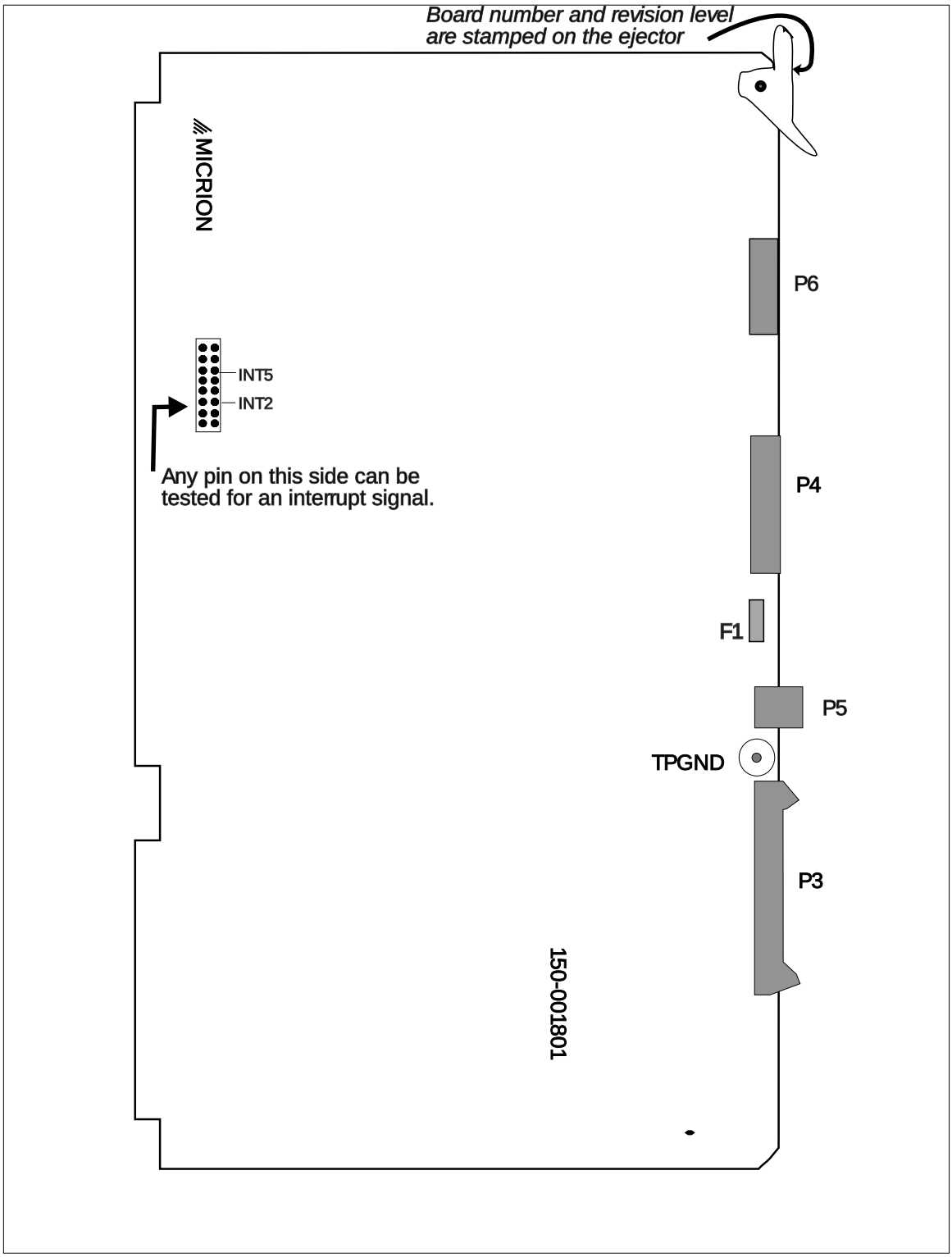


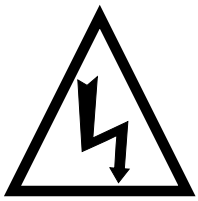
Figure 1. 1810: Knob Panel Interface

Part 1. Power Down Before Disconnecting P3 or P4

Before removing the connectors at P3 or P4 of the Knob Panel board, follow the power down procedure in Service Procedure 01-02.

Note: P3 and P4 inputs must not be interchanged.

WARNING



Dangerously high voltages are present while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and auto procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

Part 2. Testing for Interrupt Generation and Clearance

2-1. With the SysCon powered down, put the Knob Panel board on the extender board.

2-2. Unplug P3 and P4.

2-3. With an ohmmeter, test F1 for < 1 ohm.

2-4. Clip the oscilloscope probe on any input pin on the interrupt block shown in Fig. 1.

2-5. Power up the SysCon module.

2-6. In an xterm window, type the mbus_reset command:

```
mbus_reset
```

2-7. Start the Microsurgery application.

2-8. The signal from the interrupt block should be high until there is an interrupt. To generate an interrupt, turn any knob on the knob panel. The signal should go low. The computer should process the interrupt and clear it, sending it high after < 10 milliseconds. If the signal is always high, no interrupt is being generated from the knob panel. If the signal is always low, a continuous interrupt is asserted on the interrupt bus. This is a TTL- compatible signal.

Table 1 summarizes the test points.

Table 1: Knob Panel Interface Test Points

Point	Problem	Signal Characteristics If Correct
U12-pin 20	No power	5V +/- 100 mV noise
Interrupt Block	Interrupts unseen by computer	See step 2-8.
F1 (2A; Micrion p/n 540-13)	Switches/LEDs not working but keyboard is all right	<1 ohm**.**

Part 3. Interrupt Jumper

Check the interrupt jumper, which is set according to the type of computer in use.

Table 2: Jumpers

Computer	Jumper
Intel 486	INT 2
IBM 370	INT 5

Micron

Service Procedure No.: **12-06**
Service Procedure Title: **Stage/Aperture Motor Drives: 893**
Applicable Systems: **All**
Frequency of Service: **As needed**

Introduction

The stage/aperture motor drive boards enable the computer to control the stage and aperture motors.

Tools and Materials Required

Oscilloscope

Ohmmeter

ELECTROSTATIC DISCHARGE

This board is sensitive to electrostatic discharge. Handle the board as follows: 1) Touch your hand to the metal frame of the chassis to discharge static, or wear a grounding strap; 2) Hold the board by the ejector tabs; 3) If you must lay the board down, lay it component side down.

NOTICE

Per paragraph 11.1 of *Safety Guidelines for Semiconductor Manufacturing Equipment* (S2-93), this procedure is a Type 5 task. Specifically: "Equipment is energized. Measurements and adjustments require physical entry into the equipment."

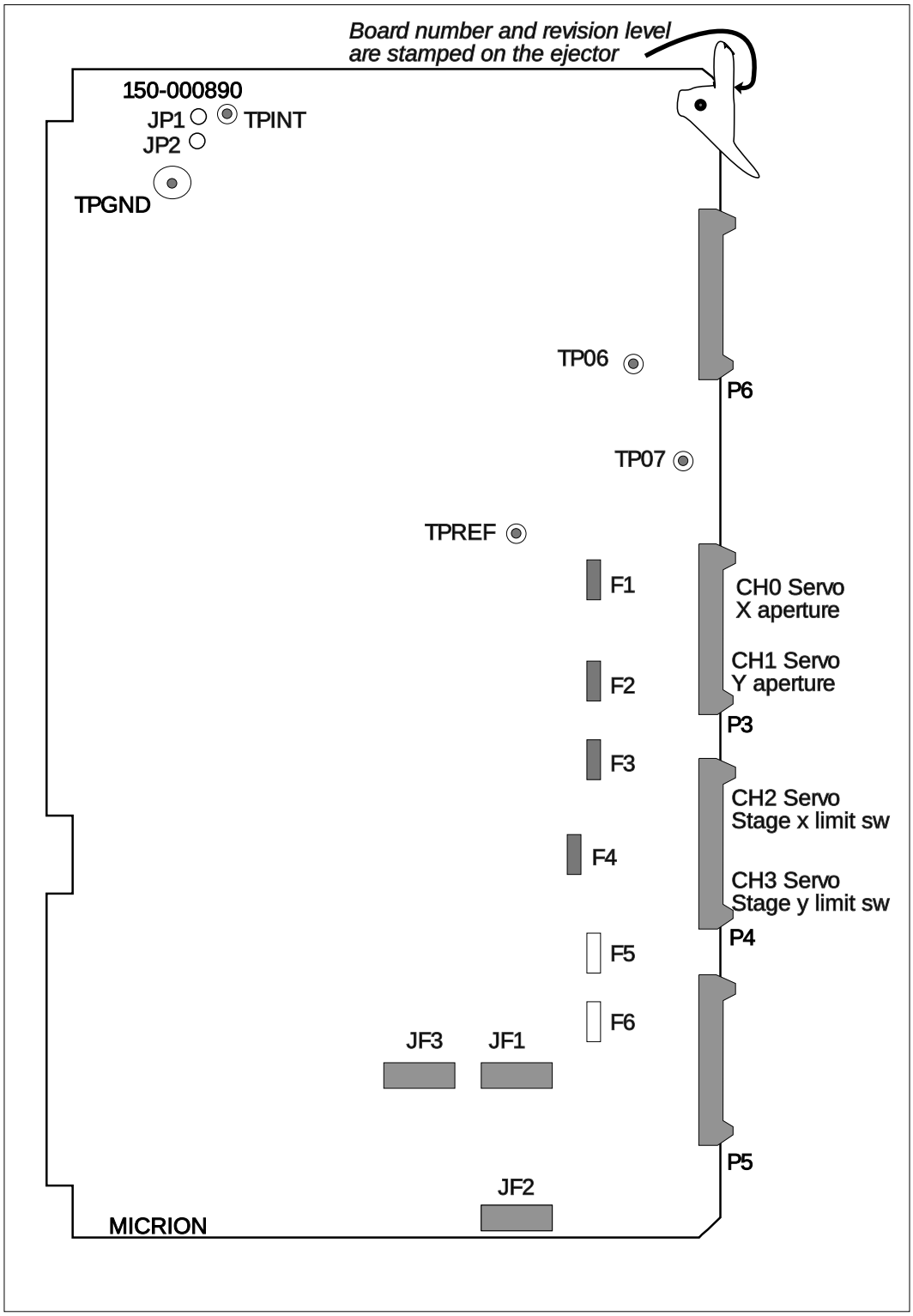
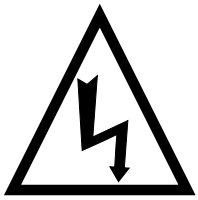


Figure 1. 893: Stage/Aperture Drives

893: Stage/Aperture Drives

Before using an extender board, power down according to Service Procedure 01-02.

See the Tables below for the test points shown in Figure 1.



WARNING

Dangerously high voltages are present while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and automatic procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

Table 1 lists the on-board fuses and the channels they control.

Table 1: Testing for stage drive and aperture drive outputs[a]

Fuse 1	Ch0; X Aperture	8 V while servo motor is in motion
Fuse 2	Ch1; Y Aperture	8 V while servo motor is in motion
Fuse 3	Ch2; X Stage	8 V while servo motor is in motion
Fuse 4	Ch3; Y Stage	8 V while servo motor is in motion
Fuse 5	Ch4; spare	
Fuse 6	Ch5; spare	
	Ch6; stepper motor	
	Ch7; stepper motor	

a. Nominal voltage is 8V; voltages depend upon speed. +8V for clockwise motion; -8V for ccw.

Table 2 lists the aperture drive output test points for the stepper clock

Table 2: Testing for aperture drive stepper clock outputs

TP6; clock	Ch6; E-beam X Aperture	Slow: 25 Hz sq wave; Fast: 120 Hz sq wave
TP7; clock	Ch7; E-beam Y Aperture	Slow: 25 Hz sq wave; Fast: 120 Hz sq wave
NOTICE: Do not short TP7 to U9. This will damage U19/U20.		

Table 3 lists the jumper settings for the 893 board.

Table 3: Jumper settings

893	JF1 (11-12); JF3 (5-6, 9-10, 11-12); JF3 (None)

Micron

Service Procedure No.: **12-07**
Service Procedure Title: **Analog Drive Board: 1081**
Applicable Systems: **All**
Frequency of Service: **As needed**

Introduction

The Analog Drive board converts digital raster data generated by the raster generator board to analog voltages that are sent to the column electronics module for beam deflection.

Figure 1 shows the Analog Drive Board and its test points, and Table 1 lists the signal characteristics of the test points.

Tools and Materials Required

Oscilloscope

ELECTROSTATIC DISCHARGE

This board is sensitive to electrostatic discharge. Handle the board as follows: 1) Touch your hand to the metal frame of the chassis to discharge static, or wear a grounding strap; 2) Hold the board by the ejector tabs; 3) If you must lay the board down, lay it component side down.

NOTICE

Per paragraph 11.1 of *Safety Guidelines for Semiconductor Manufacturing Equipment* (S2-93), this procedure is a Type 5 task. Specifically: "Equipment is energized. Measurements and adjustments require physical entry into the equipment."

Table 1: Analog Drive (AD) Board Test Points and Signal Characteristics

Point	Problem	Signal Characteristics If Correct
BSEL	Analog drive is dead.	200-500 nsec low-going pulse when communicating with the board (e.g., turning MAG knob continuously)
XDAC[1, 2]	No scan; see Raster Gen board first; test AD; see if raster definition data has been loaded.	In XY display mode, you will see a filled square. Sawtooth (if line scan) or Triangular (if serpentine); -10V to +10V signal amplitude @ freq = (scan size x dwell time) + retrace
YDAC[1, 2]	No scan; see Raster Gen Service Procedure 12-09).	In XY display mode, you will see a filled square. Sawtooth (if line scan) or Triangular (if serpentine); -10V to +10V signal amplitude @ freq = dwell time x pixels/line x lines/frame
XDEF[1, 2]	No scan, but has signal on XDAC.	Same frequency and shape as XDAC but amplitude changes as MAG is increased; may see some tilt
YDEF[1, 2]	No scan, but has signal on YDAC.	Same frequency and shape as YDAC but amplitude changes as MAG is increased; may see some tilt
XLO[1, 2]	No rotation; no signal, but has scan at XDEF.	Same frequency and shape as XDEF @ twice the amplitude; rotates when Rotate is selected.
YLO[1, 2]	No rotation; no signal, but has scan at YDEF.	Same frequency and shape as YDEF @ twice the amplitude; rotates when Rotate is selected.
XUP[1, 2]	No rotation; no signal, but has scan at XLO.	Same frequency and shape as XDEF @ twice the amplitude; rotates when Rotate is selected.
YUP[1, 2]	No rotation; no signal, but has scan at YLO.	Same frequency and shape as YDEF @ twice the amplitude; rotates when Rotate is selected.
P4	Stigmation/quad balance problem.	When quad balance is zeroed, and X and Y stig knobs are swept across range, voltage sweep is -7.5V to +7.5V. (Pin 1=Stig5; Pin 3=Stig6; Pin 5= Stig3; Pin 7= Stig4; Pin 9= Stig1; Pin 11=Stig2; Pin 13=Stig7; Pin 15=Stig8)
P4	Lens shift problem: panning function.	When quad balance is zeroed, and X and Y pan knobs are swept across range, voltage sweep is -10V to +10V. (Pin 53=XUP; Pin 55=XLO; Pin 57=YUP; Pin 59=YLO)

R103 and R116: R103 skews the X direction of the raster. R116 skews the Y direction of the raster. See Service Procedure 07-02 for complete instructions on Scan Rotation Calibration.

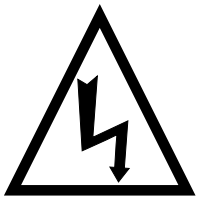
[1] Using the XY display mode on the oscilloscope, observe X and Y signals simultaneously; set Vertical Sensitivity to 5V/div on each channel. The resulting image is a box. This is the preferred way to look at signals.

[2] If using Rotated Scan, X and Y are summed; the signal is difficult to read unless in XY mode.

Part 1. Analog Drive Test Points

Before placing the board on an extender, power down according to Service Procedure 01-02.

WARNING



Dangerously high voltages are present while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and automatic procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

Micrion

Service Procedure No.: **12-09**
Service Procedure Title: **Raster Generator Board: 1110**
Applicable Systems: **All**
Frequency of Service: **As needed**

Introduction

The Raster Generator board generates digital raster data via the P2 bus to the Analog Drive board, where the digital values are converted to analog voltages for beam control and positioning.

The Raster Generator board also supplies synch signals via ribbon cable P4 to the Signal Acquisition board (1381) to synchronize A/D conversion of the imaging data.

If there is no scan occurring, test the Raster Generator board, shown in Figure 1, then test the Analog Drive board (Service Procedure 12-07).

Tools and Materials Required

Oscilloscope

ELECTROSTATIC DISCHARGE

This board is sensitive to electrostatic discharge. Handle the board as follows: 1) Touch your hand to the metal frame of the chassis to discharge static, or wear a grounding strap; 2) Hold the board by the ejector tabs; 3) If you must lay the board down, lay it component side down.

NOTICE

Per paragraph 11.1 of *Safety Guidelines for Semiconductor Manufacturing Equipment* (S2-93), this procedure is a Type 5 task. Specifically: "Equipment is energized. Measurements and adjustments require physical entry into the equipment."

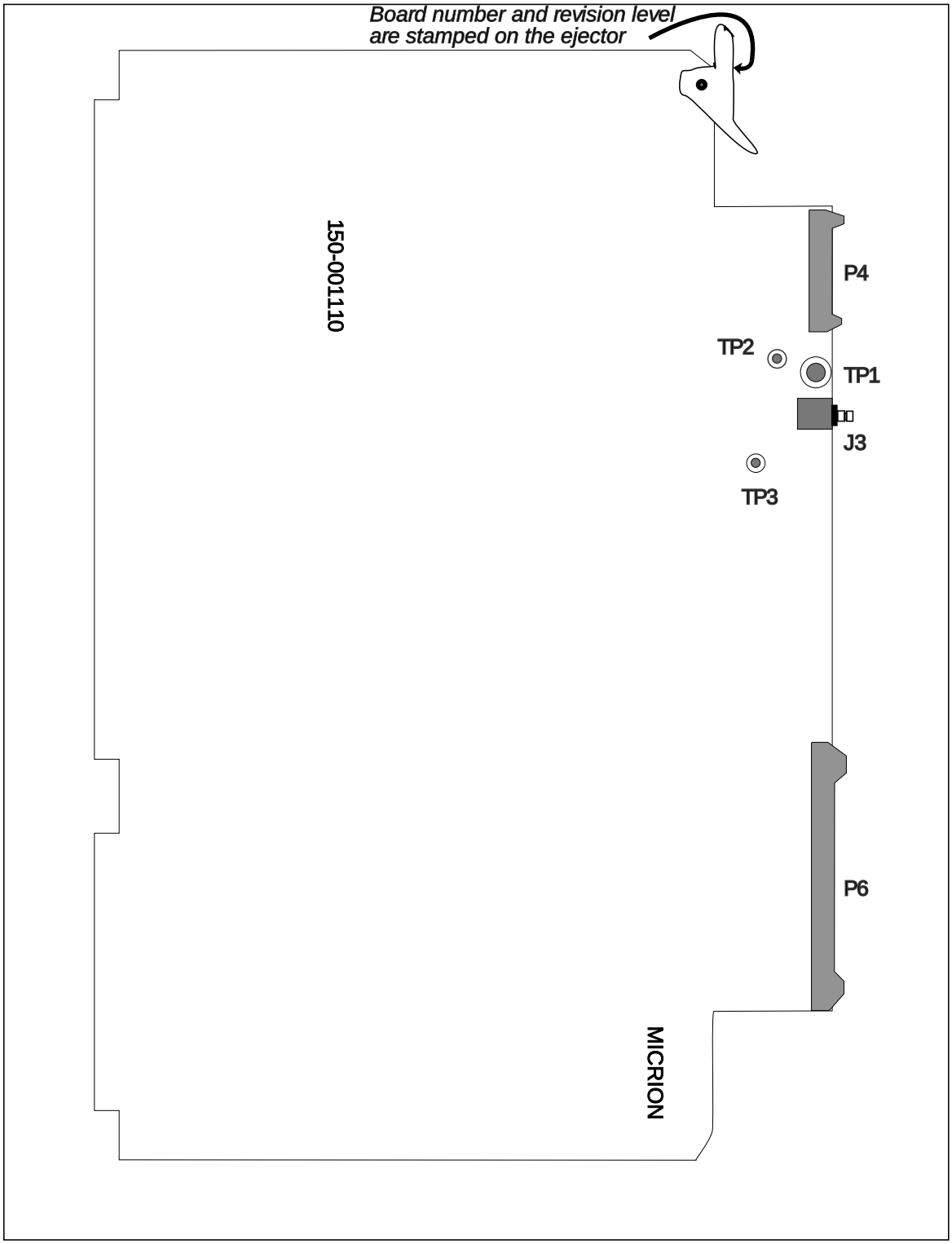


Figure 1. Raster Generator Board: 1110

Part 1. Reloading the Raster Definition Data

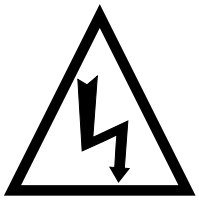
Using the rgshell program, you can reload the raster definition data.

1-1. Change directories to `/usr/micrion/fib/data`.

1-2. In an xterm window, type the following *rgshell* commands.

```
> rgshell
> dspenable 0 (initializes the routine for the definition algorithm)
> dspenable 1 (initializes the routine for the definition algorithm)
> loadalg /usr/micrion/fib/data/asm/rasta (loads the algorithm)
```

WARNING



Dangerously high voltages are present while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and automatic procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

Part 2. Checking Test Points

See Table 1 for the signal characteristics of the following test points.

2-1. Bring the power down in the SysCon as shown in Service Procedure 01-02.

2-2. Place the oscilloscope probe on the jacket of J3, and power up the SysCon as shown in Service Procedure 01-01.

2-3. Place the oscilloscope probe on TP2.

2-4. Place the oscilloscope probe on TP4, TP5, and TP6.

Table 1: Raster Generator Board Test Points and Signal Characteristics

Point	Problem	Signal Characteristics If Correct
J3 metal jacket (RS422; SMA connector)	No scan is in progress.	A pulse indicates that a beam-blanking signal is present, and the raster gen board is generating scan data; pulse is present only when raster is in progress.
TP2	No signal; SysCon must be initialized for signal to be present.	Timing signals, via P4, to the Signal Acquisition (1381) board; timing signals are present without raster in progress.
TP4, TP5, TP6		Timing signals to the Analog Drive board; timing signals are present only when raster is in progress.
P4	No signal to Sig Acq board	HSYNC, VSYNC, ADCLK, PIXCLK

If these signals are present, go to the Analog Drive (1082) board and test for presence of XDAC and YDAC.

Micrion

Service Procedure No.: **12-10**
Service Procedure Title: **Signal Acquisition Board: 1381**
Applicable Systems: **All**
Frequency of Service: **As needed**

Introduction

The Signal Acquisition board receives an analog imaging signal from the MCP, and converts it to digital form. The digital signals are passed to the Univision board in the computer module.

Tools and Materials Required

Oscilloscope

Function Generator or Test Box (Micrion p/n 100-14040)

ELECTROSTATIC DISCHARGE

This board is sensitive to electrostatic discharge. Handle the board as follows: 1) Touch your hand to the metal frame of the chassis to discharge static, or wear a grounding strap; 2) Hold the board by the ejector tabs; 3) If you must lay the board down, lay it component side down.

NOTICE

Per paragraph 11.1 of *Safety Guidelines for Semiconductor Manufacturing Equipment* (S2-93), this procedure is a Type 5 task. Specifically: "Equipment is energized. Measurements and adjustments require physical entry into the equipment."

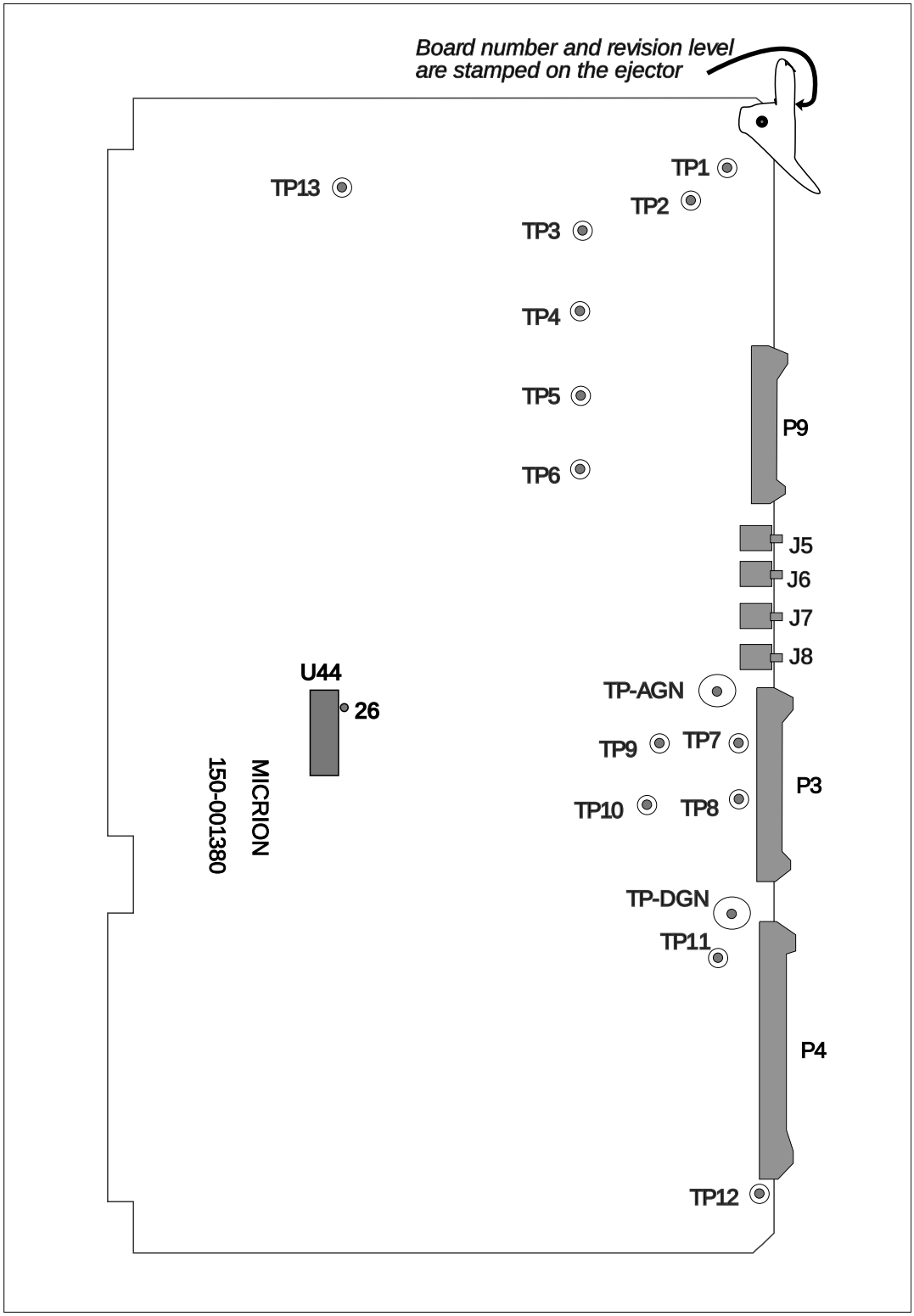


Figure 1. 1381: Signal Acquisition

1381: Signal Acquisition

First, try TPs 1, 2, 7, 8, 11, and 12. For the remaining test points, use an extender board.

Table 1: 1381 Test Points

Test Point	Problem	Signal Characteristics if Correct
TP1	Imaging; video electronics gain (See Part 1)	With HV enabled and the scan at "Stop", the DC voltage at TP1 should be +1V to +2V. With scan at "Start", TP1 has a video signal summed with the dc level; in electron mode, 200mV to 300mV p-p
TP1		The amplifier on the signal acquisition board can be checked as follows: Disconnect the light link cable; cover the light-receiving diode; **100 mVoff-set max.**
TP2	Brightness control; video electronics gain (See Part 1)	-5VDC to +5VDC; can be adjusted across full range by means of the brightness knob
TP3 - TP6 (Q4-Q1)	Multiplex imaging, quad anode MCP video amplifi-ers; video electr gain (see Part 1)	With HV enabled and the scan at "Stop", and after calibration using pulldown menu, DC voltage at all test points = TP2 within +/- 10 mV
TP7	SysCon power	+15VDC (+/- 3%**)**
TP8	Imaging problems; bbaper, ionf, elecf; video electronics gain (See Part 1)	Using the Brightness knob, you should be able to adjust from +0.5V to -2.5V**.** **Input to video A/D.**
TP9	SysCon power	-15VDC (+/- 3%)
TP10	Imaging problems; bbaper, ionf, elecf	-5VDC (+/-5%); power for 8-bit flash ADC; ripple < 50mV p-p
TP11	SysCon power	+5VDC (+/- 3%)
TP12	Pixels; Imaging problems; bbaper, ionf, elecf measure-ment	When making column sense measurements, pixel clock is a pulse train of 4k pulses @ 24 µsec period (100 msec burst)
TP13 [8000 only]	Quad anode offset DAC; quad calibration	+2V (+/-5%); reference for quad anode offset DAC
U44 pin 26	Imaging problems; bbaper, ionf, elecf	-2VDC (+/-5%); reference for 8-bit flash ADC; ripple < 50mV p-p

Part 1. Video Electronics Gain Test

1-1. Power down as described in Service Procedure 01-02 so you have safe access to both the MCP power supply and the SysCon boards.

WARNING

Dangerously high voltages are present while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and auto procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

To verify the gain and bandwidth characteristics of the video electronics chain, proceed as follows:

1-2. Setup the function generator for 10 kHz (-60mV) square wave or use the test box.

1-3. Switch off the *MCP* power switch above the SysCon module.

1-4. Open the MCP power supply box (aka CEM box).

1-5. Attach the function generator GND to one of the screws inside the MCP box.

1-6. Attach the function generator output to TP1 on the Preamp board (see Fig. 2).

1-7. Switch on the MCP power switch above the SysCon module.

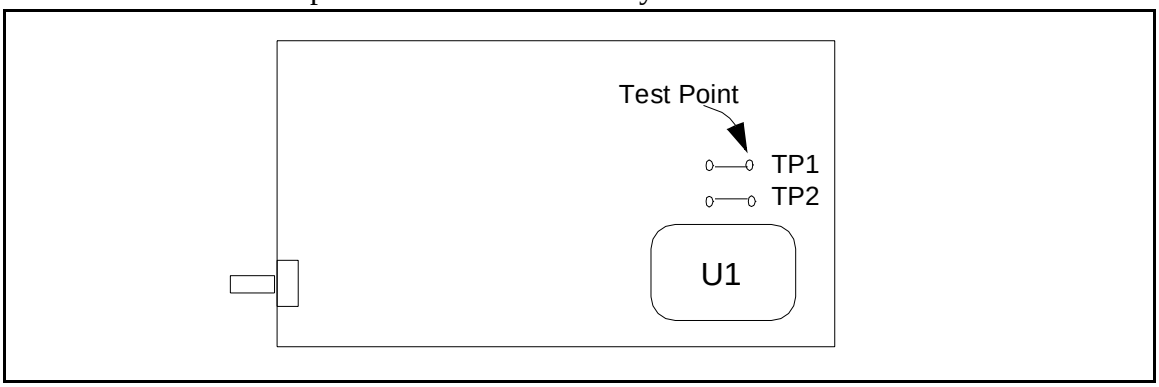


Figure 2. Location of TP1 on Preamp board.

1-8. At TP1 of the Signal Acquisition board the voltage should be between 150 mV and 300mV peak to peak on 1V-2V DC level.

1-9. Use the *Brightness* knob to center the 10 kHz square wave; the voltage at TP8 of the Signal Acquisition board should be between 1.7V and 2.0V peak to peak.

As you start imaging, the image should appear as in Fig. 3.

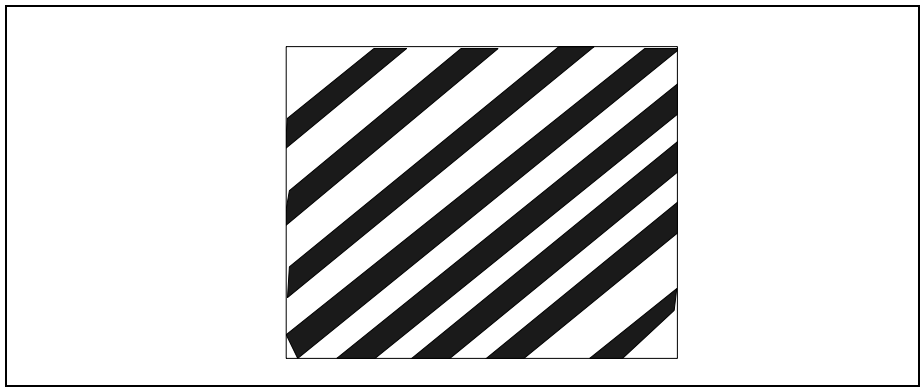


Figure 3. Test Image at 10 kHz

Part 2. Checking Scan Signals to the Univision Board

In this procedure you check the Univision connector for the signals listed in Table 2. The Univision connector is at slot 2 at the back of the computer (see Fig. 4).

The correct waveforms for the signals in Table 2 are shown in Figures 5, 6, and 7. To check the functionality of the Univision board, you can view a TIFF file. If the image is correct, the board is functioning.

2-1. To see the positive voltages, adjust the brightness to black.

2-2. Disconnect the 37-pin Univision connector.

2-3. While scanning (in Electron mode at Fast scan) compare your signals with the waveforms shown in Figures 5, 6, and 7.

Table 2: Univision Board Scan Signals

Signal	37-Pin Connector to Univision Board (See Fig. 4)
Pixel clock POS (PIXCLK+)	Pin 1
Pixel clock NEG (PIXCLK-)	Pin 20
Horizontal Sync POS (HSYNC+)	Pin 2
Horizontal Sync NEG (HSYNC-)	Pin 21
Vertical Sync POS (VSYNC+)	Pin 3
Vertical Sync NEG (VSYNC-)	Pin 22
Video Data POS ($VD0^{+}$-$VD7^{+}$)	Pins 8-15
Video Data NEG ($VD0^{-}$-$VD7^{-}$)	Pins 26-33

Part 3. Observing Video Data Bits on the Univision Connector

3-1. While scanning, turn the *Brightness* knob to full black.

3-2. Disconnect the 37-pin Univision connector and test the signals coming from J2220 of the rear of the SysCon module (see Fig. 4).

3-3. With an oscilloscope, check pins 8-15. They should be at logical 0 (0.8V max).

3-4. With an oscilloscope, check pins 26-33. They should be at logical 1 (2.5V min).

3-5. Reconnect the 37-pin Unvision connector.

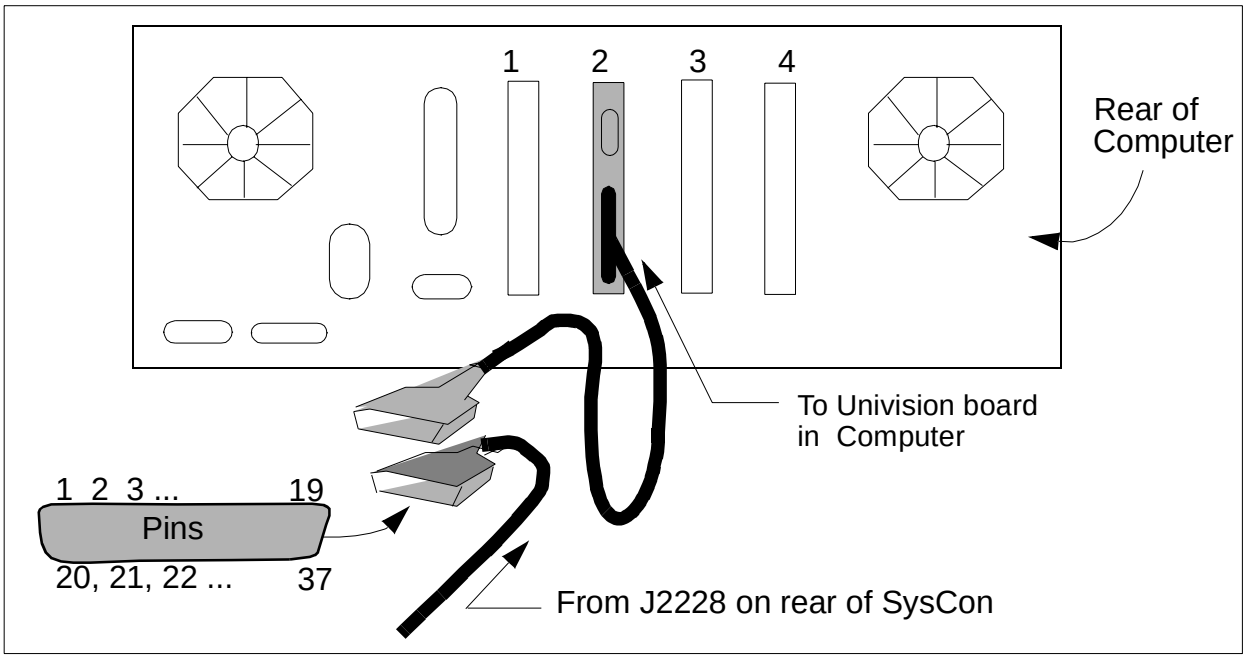


Figure 4. 37-Pin Univision Connector at Rear of Computer Module

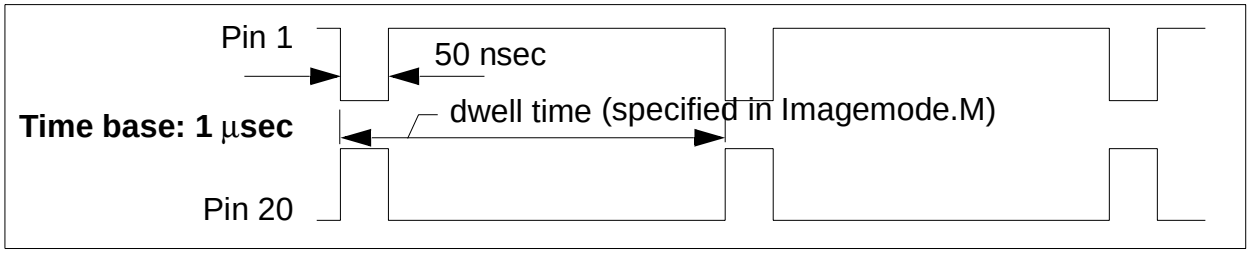


Figure 5. PIXCLK: typically 1-16 µseconds

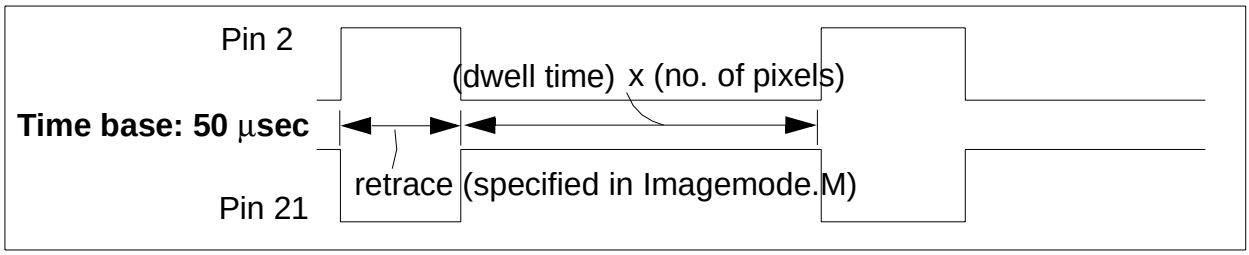


Figure 6. HSYNC: typically hundreds of µseconds

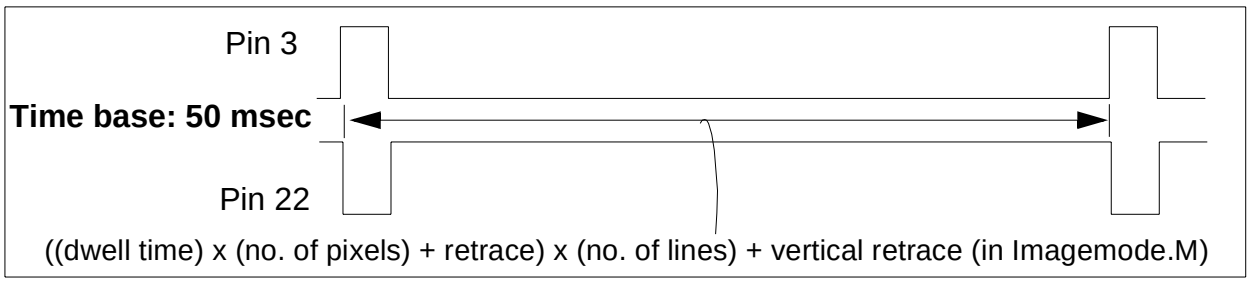


Figure 7. VSYNC: typically hundreds of mseconds

3-6. Adjust the *Brightness* to full white.

3-7. Disconnect the 37-pin Univision connector.

3-8. With an oscilloscope, check pins 8-15. They should be at logical 1 (2.5V min).

3-9. With an oscilloscope, check pins 26-33. They should be at logical 0 (0.8V max)

Micrion

Service Procedure No.: **12-11**
Service Procedure Title: **Flood Gun Interface: 1090**
Applicable Systems: **All**
Frequency of Service: **As needed**

Introduction

The Flood Gun Interface (FGI) board is the digital controller for the Flood Gun Supply board (1130). The FGI board performs digital to analog conversions to the supply voltages on the Flood Gun Supply board via a ribbon cable to P3 (see Figure 1). The FGI also provides a readback from the Flood Gun Supply board, converting analog values to digital and sending them on to the computer.

Tools and Materials Required

- Voltmeter
- Oscilloscope

See Service Procedure 05-04, Flood Gun Installation and Test.

ELECTROSTATIC DISCHARGE

This board is sensitive to electrostatic discharge. Handle the board as follows: 1) Touch your hand to the metal frame of the chassis to discharge static, or wear a grounding strap; 2) Hold the board by the ejector tabs; 3) If you must lay the board down, lay it component side down.

NOTICE

Per paragraph 11.1 of *Safety Guidelines for Semiconductor Manufacturing Equipment* (S2-93), this procedure is a Type 5 task. Specifically: "Equipment is energized. Measurements and adjustments require physical entry into the equipment."

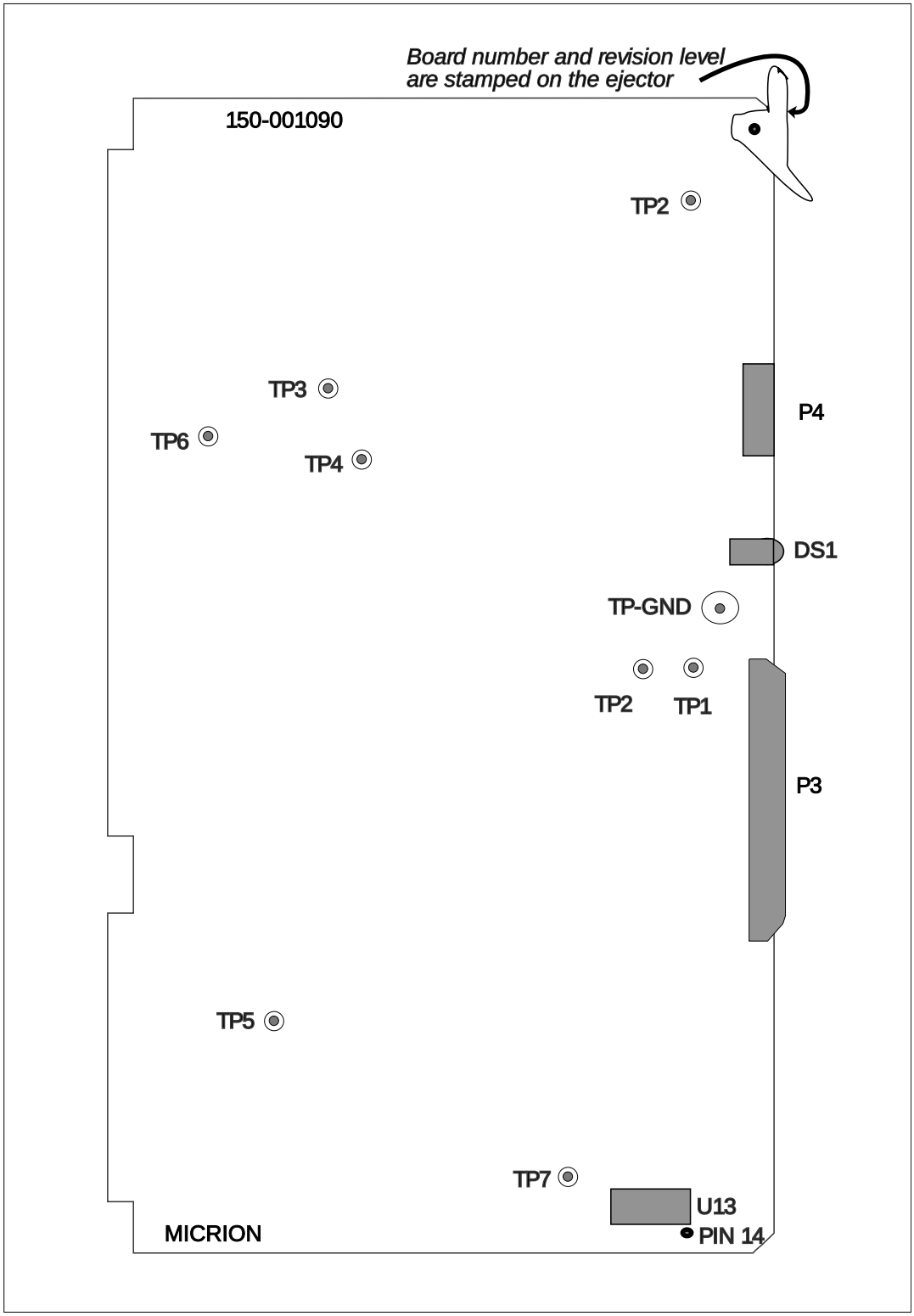


Figure 1. 1090: Flood Gun Interface

Part 1. DS1 As Indicator of Flood Gun Supply

As shown in Table 1, if the LED (DS1 in Figure 1) is illuminated, the Flood Gun Supply board is sending high voltages to the Flood Gun. If DS1 is off, no voltages are available to the Flood Gun, except for -25V, as shown in Table 1.

When DS1 is off, the high voltages still exist on the Flood Gun Supply board.

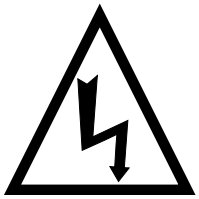
Table 1: DS1 As Indicator of Flood Gun Supply

DS1	Flood Gun Supply voltages on the Flood Gun in Workchamber
ON	YES
OFF	NO (except for -25V)

Part 2. Test Points for the Flood Gun Interface

2-1. To reach the test points listed in Table 2, first power down as described in Service Procedure 01-02.

WARNING



Dangerously high voltages are present while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and automatic procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

2-2. Place the Flood Gun Interface board on the Multibus extender board and plug the extender into the same slot.

2-3. Put the oscilloscope probe on TP2, and power the SysCon back up. See Table 2 for signal characteristics.

2-4. Continue checking the test points in Table 2.

Table 2: Test Points for the Flood Gun Interface

Test Point	Function	Signal Characteristics
TP2	A/D Clock	1.25 MHz square wave
TP4		50 Hz square wave
TP5	Reference for DACs	10V
TP7	Reference for DACs	10V
U13 pin 14	Reference for DACs	5V

Potentiometers R13 and R18

Do not adjust potentiometers R13 and R18. They cannot be accurately adjusted in the field.

Micrion

Service Procedure No.: **12-12**
Service Procedure Title: **Flood Gun Supply: 1130**
Applicable Systems: **All**
Frequency of Service: **As needed**

Introduction

The outputs of the Flood Gun Supply board are enabled and disabled by the Flood Gun Interface board (see Service Procedure 12-11). The Flood Gun Supply board receives commands on P3 via the ribbon cable from the Flood Gun Interface board (see Figure 1).

The Flood Gun Supply board generates high voltages on the board as soon as the SysCon chassis main power switch (CB1) is turned on. When the *Flood Gun* switch (S3) on the SysCon module is on, high voltages will be sent to the flood gun.

Testing the Flood Gun supply board is difficult. Many of the test points are close together, and any shorting of test points will destroy the board. Follow the simple procedure of looking for noise, looking for burn marks, and testing the three voltages noted in Part 4.

Tools and Materials Required

- Voltmeter (with clip leads; any other leads can slip and cause short circuits)
- Multibus extender board

Also see Service Procedure 05-04, Flood Gun Installation and Test.

NOTICE

Per paragraph 11.1 of *Safety Guidelines for Semiconductor Manufacturing Equipment* (S2-93), this procedure is a Type 5 task. Specifically:
"Equipment is energized. Measurements and adjustments require physical entry into the equipment."

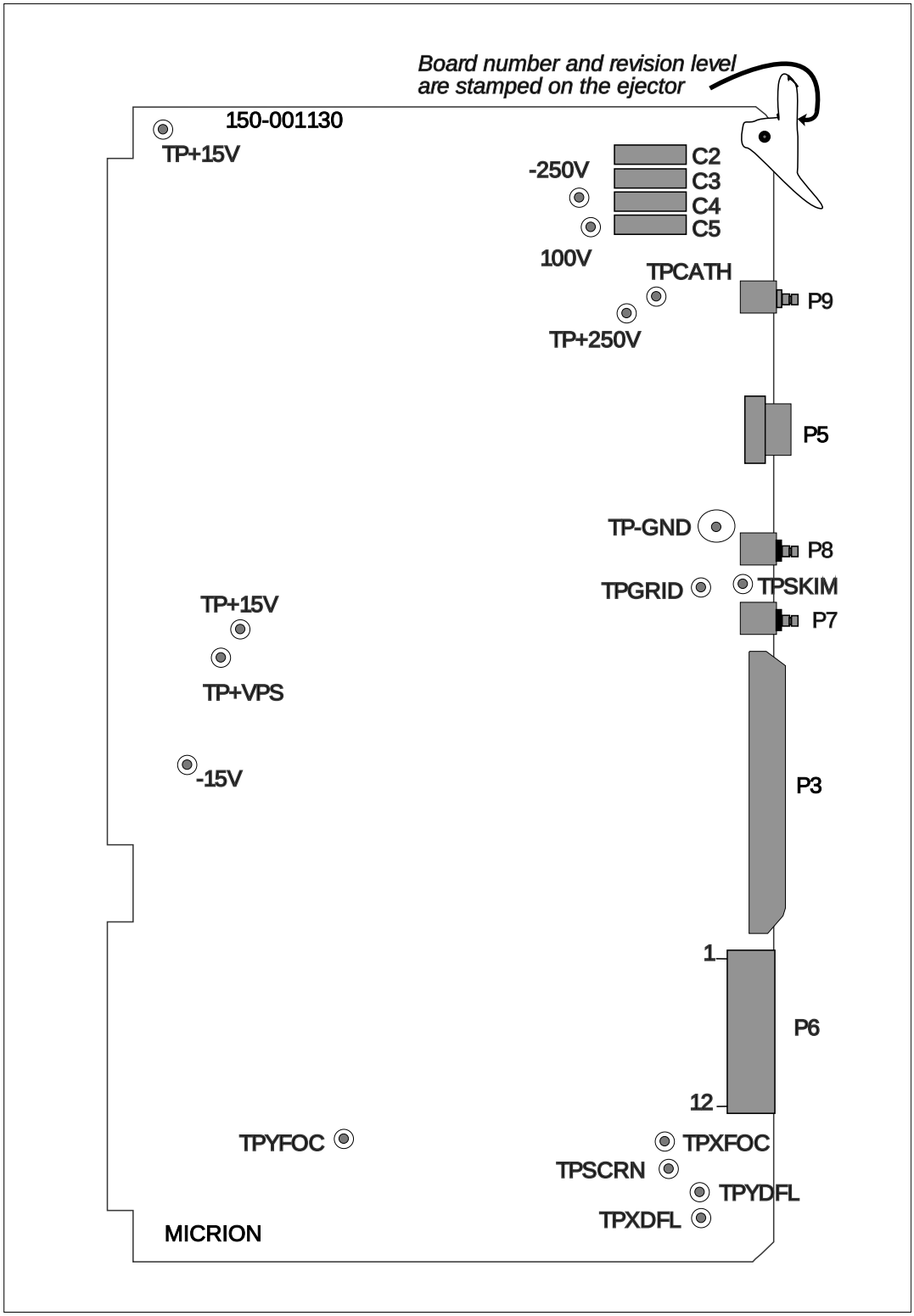


Figure 1. 1130: Flood Gun Supply Board

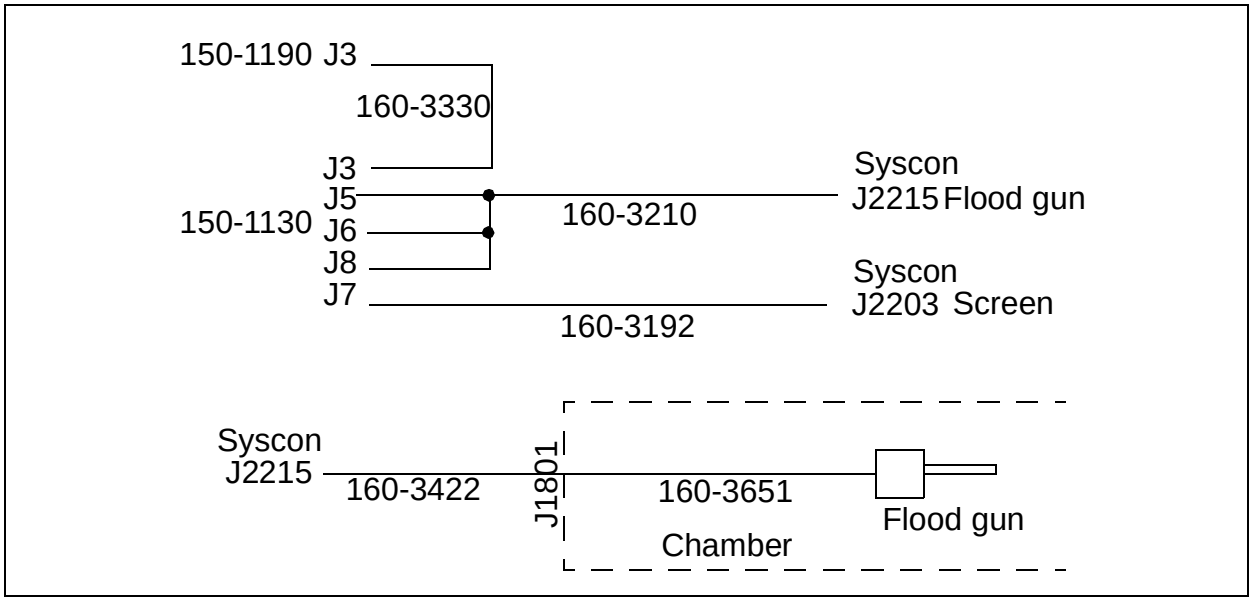


Figure 2. 8000 Syscon-to-Flood Gun Block Diagram

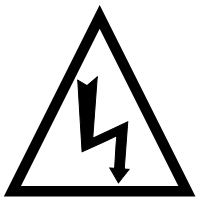
Part 1. Listen for High-frequency Audible Noise.

At power up, if you hear a high-frequency whine, it usually means that the board is having difficulty generating the high voltages.

Part 2. Examine the Board for Burned Resistors.

2-1. Use the power down procedure (see Service Procedure 01-02), then remove the board.

WARNING



Dangerously high voltages are present in the process module while the FIB system is powered up. Do not rely *only* on the software Power Down function. Disable the voltages using both manual and automatic procedures, as described in **Service Procedure 01-02**. Do not proceed until you have switched off the applicable power supplies**.**

ELECTROSTATIC DISCHARGE

This board is sensitive to electrostatic discharge. Handle the board as follows: 1) Touch your hand to the metal frame of the chassis to discharge static, or wear a grounding strap; 2) Hold the board by the ejector tabs; 3) If you must lay the board down, lay it component side down.

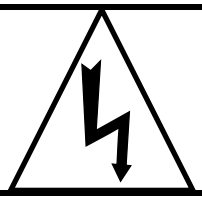
2-2. Visually inspect the board for scorched parts. If you see scorched or burned parts, return the board to Micrion and order a replacement.

Part 3. Use an Extender Board

3-1. If the parts appear to be unscorched, place the board on a Multibus extender board.

Part 4. Check the 100V, -250V, and +250V Test Points

4-1. Before testing any of the following points, be aware of the high voltage warning.



WARNING: HIGH VOLTAGE

Whenever the chassis main power switch (CB1) is turned on, the Flood Gun Supply generates high voltages on the board. Use extreme caution.

NOTICE: SHORTING TEST POINTS IS EASY

If you short any of these high voltages, this board will be damaged. Be extremely careful when handling this board, especially versions that do not have an insulated back cover.

Check for 100V

4-2. Use the TPGND test point as chassis ground.

4-3. Probe the 100V test point for the following (see ejector tab for rev no.):

REV C1 and earlier: 100V (between 95V and 105V)
REV C2 and later: 115V (between 112V and 118V)

Check for -250V

4-4. Use the TPGND test point as chassis ground.

4-5. Probe the -250V test point for the following (see ejector tab for rev no.):

REV C1 and earlier: -250V (between -238V and -262V)
REV C2 and later: -225V (between -214V and -236V)

Check for +250V

4-6. Use the TPGND test point as chassis ground.

4-7. Probe the +250V test point for between +238V and +262V (all REVs).

Checking Test Points

4-8. TPXFOC: Depending upon user input, voltage swings from 0V to +200V.

4-9. TPXDFL: Depending upon user input, voltage swings from -100V to +97V.

4-10. TPSCRN: Depending upon user input, voltage swings from -200V to +100V.